# THE DESIGN OF VISITOR'S SHED IN DHAKA ZOO: "GOLDEN FIBER" JUTE AS TENSILE MEMBRANE

# **Master-Thesis**

A thesis submitted in partial fulfillment of the requirements for the degree of

Master Membrane Structures

submitted to

Anhalt University of Applied Sciences

Faculty of Architecture, Facility Management and Geo Information

by

Golam Morsalin, Choudhury Rana 31-December-1985, Laxmipur, Bangladesh

4053857

Submission date: 24-2-1985

First Tutor: Prof. Dr. Ing. Robert Off

Second Tutor: M.Eng. Atisit Sabmeethavorn

#### Statement

I hereby declare that the work presented in this Master thesis, entitled

The Design of Visitor's shed In Dhaka Zoo: "Golden Fiber" Jute as Tensile Membrane,

is entirely my own and that I did not use any sources or auxiliary means other than those referenced.

Dhaka, Bangladesh, 24-2-2013

Golam Morsalin Choudhury Rana

1

#### Acknowledgement

I would like to thank all the people who helped me in preparation of this thesis work. First of all I would like to mention Prof. Dr. Robert Off for his continuous support throughout the course. I would like to thank him for his dedication and passion in handling entire course work at Institute for Membrane and Shell Technologies, IMS e.V.

I would like to my gratitude to Atisit Sabmeethavorn for his guidance and support throughout the thesis work. I will always remember his dedication and kind behavior through the course.

I would like to express my special thanks to Prof. Dr. Shabbir Ahmed, Department of Architecture, Bangladesh University of Engineering and Technology, BUET for his inspiration, encouragement and support throughout the course.

I would like to thank following individual:

Md. Moslem Uddin from Textile Physics Division of Bangladesh Jute Research Institute, BJRI for his continuous untiring support and guidance on my thesis work.

Prof. Dr. Abdul Jabbar Khan, Department of Civil Engineering, Bangladesh University of Engineering and Technology, BUET for his guidance on material testing.

Heike Kleine, Assistant IMS e. V. for her support, patience and providing license key whenever author needed.

Architect Amandus VanQuaille, Nomad Concept Belgium for his technical support.

Finally this thesis is whole heartedly dedicated to my parents for their relentless support, love and affection.

Golam Morsalin Choudhury Rana Dhaka, 24 February 2013

# **Table of Contents**

| Statement   | 1          |
|---|------------|
| Acknowledgement   | - <b>2</b> |
| Table of Contents   | - 3        |
| Abstract  | . 4        |
| Chapter01: Introduction   |            |
| 1.1 Introduction  | - 5        |
| 1.2 Objectives  | - 5        |
| 1.3 Scope and Limitations   | . 5        |
| 1.4 Approach  | · 6        |
| 1.5 Thesis Structure  | · 6        |
| References  | . 6        |
| Chapter 02: Tensile membrane structures and history of fabric structures in Banglades | sh         |
| 2.1 Tensile membrane structures   | 7          |
| 2.2.1 Qualities of Membrane Structures  | 7          |
| 2.2 History of Fabric Structures in Bangladesh  | 9          |
| References  | 10         |
| Chapter03: Jute   |            |
| 3.1 Introduction of Jute  | 11         |
| 3.2 Properties of Jute  | 12         |
| 3.3 Jute Fabrics  | 13         |
| 3.3.1 Jute Geotextiles  | 13         |
| 3.3.2 Jute Cotton Union Fabrie  | 14         |
| 3.4 Strength Test   | 14         |
| 3.5 Cost Comparison   | 15         |
| 3.6 Review of Recent Research and Developments  | 15         |
| Chapter04: Design Development   |            |
| 4.1 Project Background  | 18         |
| 4.1.1 Project Requirements  | 19         |
| 4.1.2 Site Description  | 19         |
| 4.2 Conceptual Development  | 20         |
| 4.3 Physical Model Stud <del>y</del>  | 22         |
| 4.4 Formfinding   | 23         |
| 4.5 Shadow Study  | 24         |
| 4.6 Membrane Analysis   | 25         |
| 4.6.1 Wind Load   | 25         |
| 4.6.2 Snow Load   | 26         |
| 4.6.3 Load Combinations   | 26         |
| 4.6.4 Maximum Stress and Membrane Selection   | 28         |
| 4.6.5 Displacement of the Membra <del>ne</del>  | 28         |
| 4.7 Patterning  | 29         |
| 4.8 Detail Design   | 32         |
| 4.8.1 Cable Dimensioning  | 32         |
| 4.8.2 Membrane Corner Design  | 34         |
| 4.8.3 Connection Design   | 35         |
| 4.8.4 Mast Design   | 38         |
| 4.8.5 Anchorage Design  | 39         |

## Chapter05: Fabrication

| 5.1 Cost Estimation  | 40 |
|--|----|
| 5.2 Time Schedule  | 40 |
| 5.3 Erection Procedure                                       | 41 |
| Chapter06: Conclusion  |    |
| Conclusion   | 42 |
| Bibliography   | 43 |
| List of Figures and Table <del>s</del>                       | 44 |
| Appendix01: Tensile Strength Lab Test Results                | 46 |
| Appendix02: Cost Estimation                                  | 49 |
| Appendix03: Membrane Stresses in Different Load Combinations | 51 |
| Appendix04: Forten Analys <del>is Report</del>               | 58 |
| Appendix04: Foundation Detail Drawing                        | 66 |
| Appendix05: Structural Calculation                           | 67 |
|  |    |

#### Abstract

This paper explores the opportunity of using Jute fabric as an alternative material for tensile membrane structures. Jute has many environmental benefits. It is biodegradable, nontoxic and has high tensile strength. Application of Jute based product is green, sustainable and reduces carbon footprint.

Jute cord, ropes, bags are being used for centuries, and Bangladesh is the natural home of the best quality Jute. Bangladesh is the largest Jute exporter in the world. Wide range of products is made from Jute. Technical textiles such as Jute geotextiles (JGT) made from Jute are being used in road construction, river bank erosion control, filtration etc. Many researches are being undertaken to improve the quality and longevity of Jute. One study indicates that chemically treated Jute fabric can last upto 20yrs.

Tensile fabric structures are special type of structures where roofs or canopies were loaded only in tension. Tensile fabric structures are lightweight, translucent, flexible, and have sculptural quality comparing to traditional structures. These qualities tensile membrane structures match the requirements of visitor's shed design in Dhaka zoo.

Since Jute is an indigenous material, locally available, low cost, ecofriendly and has good tensile strength, so Jute fabric is selected to be used as an experimental tensile fabric material for the proposed shed structure in Dhaka Zoo. The combination of Jute fabric and support structure will add sculptural quality and lightweightedness in zoo environment. This study will open up possibilities of Jute fabric to become an alternative for tensile fabric structures.

4

#### Chapter 01:

#### Introduction

#### 1.1 Introduction

Tensile membrane structures are very lightweight and require minimum supporting structures to be built<sup>1</sup>. Sculptural forms & shapes of them attract people. They can be temporary & mobile and require less hard surfaces. These advantages are suitable for a visitor shade. So, tensile membrane structure is selected to design a visitor shade in Dhaka Zoo.

Prestressed membrane is used for structural stability in tensile membrane structures. The materials used for membranes are generally consisting of artificial woven fabric coated with polymeric resin<sup>2</sup>. Natural fabric such as fabric made of Jute fiber has huge potential to become an alternative membrane material. As Jute fiber has good tensile strength. Jute ropes and bags are widely used to carry loads. Jute has many ecological benefits. It is environment friendly, nontoxic and biodegradable. Recent study shows that treated Jute fabric can last upto 20yrs<sup>3</sup>.

Selecting natural fiber based products rather than synthetic fibers can reduce  $CO_2$  emission. Thereby reducing greenhouse effect caused by  $CO_2$ . Increasing awareness in this issue leads to more in depth research on natural resources. The industrial and natural life cycles of a product made from renewable resources shown in Fig. 01.  $CO_2$  produced by incineration at the end of technical cycle is compensated through photosynthesis during growth making total  $CO_2$  balance is zero<sup>4</sup>.



Figure 1: Interaction between natural and industrial cycles. (Reported by Loan, 2006)

Jute is an indigenous material of Bangladesh. Bangladesh is the natural home of best Jute in the world. Jute is readily available and cheap. Bangladesh is the largest exporter of raw Jute in the world<sup>5</sup>. Jute is related with development of economy and poor rural communities in Bangladesh. Govt. of Bangladesh is encouraging diversified uses of Jute. Technical textiles produced from Jute fabric such as Jute Geotextiles (JGT) are one of the diversified uses of Jute, which are now used in road construction, preventing soil erosion, filtration etc<sup>6</sup>.

#### 1.2 Objectives

This paper investigates the potential of Jute fabric to be used as tensile membrane for visitor shade at Dhaka Zoo. It will enhance the applicability of Jute fabric and lead the way to future in depth study on Jute fabric as a membrane material.

#### **1.3 Scope and Limitations**

This study is mainly focused on Jute fabric available in local market. Among them one side laminated hessian type Jute fabric and Jute-cotton 50:50 union fabric tested in BUET lab. Double side coated fabric is not available but it can be produced in factory only for large quantities.

Testing of the Jute fabrics have been done in the labs of Bangladesh University Engineering & Technology (BUET) and Bangladesh Jute Research

#### Institute (BJRI).

Jute fabrics which are selected in this study are not UV protected and weldable. Researches are going on to make Jute fabric UV protected. There are possibilities to make it weldable, but it is out of the scope of this study.

#### 1.4 Approach

The approach to design a visitor shed using Jute fabric will be divided into two phases. In study phase a suitable Jute fabric will be selected based on literature review and market survey. Then in design phase after loadcase analysis, strength of the fabric will be checked if its strength is above the required safety level than the fabric will be selected for detail design.



#### **1.5 Thesis Structure**

After introduction in chapter01, background of the thesis work will be discussed in chapter 02. A short overview on tensile membrane structures and a short history of fabric structures in Bangladesh will be discussed. And then project description and site location will be presented.

In chapter 03 Jute, properties of Jute yarn, Jute geotextiles, Jute cotton union fabrics will be studied thoroughly and a fabric will be selected based on tensile strength for design phase.

Then in chapter 04 design will be developed and form finding will be done. Membrane will be analyzed for different load cased. Then strength of the fabric will be evaluated. If it is ok then detail design will be done.

The fabrication process will be discussed in chapter 05. Cost estimation, time schedule will be presented. A guideline for erection procedure will be given.

Conclusive remarks and evaluation of the findings will be discussed in chapter 06

#### **References:**

- 1. Brian Forster, Marijke Mollaert; Engineering Fabric Architecture, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 2. Rainer Blum, Heidrun Bogner, Guy Nemoz; Material Properties and Testing, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 3. Dr. A.B.M. Abdullah, Jute Geotextiles and Their Applications, Jute Diversification and Promotion Center (JDPC), Dhaka 2008.
- 4. Doan, Thi Thu Loan, Investigation on Jute fibers and their composites based on polypropylene and epoxy matrices, Technischen Universität Dresden, May 2006.
- 5. World Export report of raw Jute, Kenaf and allied fibers from 2003/2004 to 2009/2010, Food and Agriculture Organization (FAO)
- 6. Dr. A. B. Jabbar Khan, Technical Assessment of Jute Geotextiles for Civil Engineering Applications, Department of Civil Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, June 2008

#### Chapter 02:

#### Tensile membrane structures and history of fabric structures in Bangladesh

#### 2.1 Tensile Membrane Structures

Tensile membrane structures are generally composed of lightweight membrane or fabric and primary structure, where membrane is loaded only in tension supported by primary structure. Tensile membrane structures are lightweight, flexible and more stable than conventional structures<sup>1</sup>. Modern tensile fabric structures have relation and similarities with traditional and nomadic tents. The materials of old nomadic tents were hand woven wool with wooden stakes as primary structure. But the modern tensile membrane structure uses steel masts, arches, semi-grid support as primary structure and membrane with associated cables as secondary structures<sup>2</sup>.

The art of modern lightweight membrane structure started from 1950's. 'Minimal surface' concept of modern membrane structures are based on Frei Otto's soap film experiments. Minimal surface requires least amount of potential energy within a set of boundary. With minimally shaped surfaces varieties of sculptural shapes and spaces can be produced. They can be translucent and provide shade from sun, rain, wind. So with minimally shaped surfaces more can be achieved with less, in other words- less is more<sup>3</sup>.

#### 2.1.1 Qualities of Membrane Structures

Tensile membrane structures have some advantages over traditional structures. The major advantage of tensile membrane structures is its lightweightness. Prestessed shapes of the membrane, low mass and wide span provide opportunity to express lightness and stability<sup>3</sup>.



Figure 3: Fountain Tent Starwave, Cologne, Germany, rebuilt 2000, Architekturbüro Rasch + Bradatsch with Frei Otto.

Translucency is one of the great qualities of tensile membrane structures. It offers aesthetic opportunity to design with natural and artificial light. Translucency depends on the type, coating and color of membrane material. Translucency can vary from 10% to 40%<sup>3</sup>.



Figure 4: Assembly Tent, Malaysia, 1997, SL Rasch

Tensile membrane structures are not rigid. Membrane shape deforms in response to snow and wind load. It finds efficient shape for different loading conditions which offers better flexibility. Unique sculptural shapes can be achieved through membrane structures. It offers a floating quality defying gravity. With the help of artificial lighting it offers an opportunity to design a tensile membrane structure into a sculpture of light<sup>3</sup>.



Figure 5: Julianus Shopping Mall, Tongeren, Belgium, 2007, The Nomad Concept

Membrane material with open structure can be used for shading and stimulate natural ventilation. The open air feeling and impression of lightness of tensile membrane structures are reinforced by the translucency of membrane material<sup>3</sup>.



Figure 6: Fort 4 Mortsel, Antwerp, Belgium, 2002, The Nomad Concept

Tensile membrane structures can be the synthesis of nomad tent and permanent settlement. Flexibility and lightness of materials make them to be built again and again in different places. They can be erected again and again at different places. For these mobility and flexibility tensile membrane structures can be used in case of emergency situations and also they can be served for various open public events, which in turn save urban open spaces.

#### **1.2 History of Fabric Structures in Bangladesh**

Bangladesh has a long tradition of fabric structures, which has been influenced by many traditions and cultures in this region. Traditional fabric structures like Pandal and Shamiana are being erected throughout the history as temporary shelters for different festivals and ceremonies. Pandals are generally erected as temporary shed for different religious festivals & weddings especially by Hindus and Buddhist from ancient times. Hindu community in Bangladesh set up large puja pandals during *Durga Puja* to venerate the goddess Durga<sup>4</sup>. Traditional ceremonial tent Shamiana was introduced by Mughal regime in India<sup>5</sup>. Shamiana was richly decorated fabric hanged in Mughal and Rajput courts. It's a temporary structure erected on different royal or public events.



Figure 7: Mughal Shamiana in front of Divan-i Khass in the Palace of the Delhi Fort, water color by Ghulam Ali Khan, 1817



Figure 8: Durga puja pandal, author Mukerjee, October 2008



Figure 9: A Pandel gateway in Dhaka.( Author Pro. Dr. Shabbir Ahmed, 2011)



Figure 10: 10th convocation pandel of Bangladesh University of Engineering & Technology (BUET), 3rd February 2011

Shamiana or pandals are still being erected during various religious festivals, public events, parties, marriage ceremonies etc. One of the biggest examples is 'Bisho Ijtema'. Largest tent structure using jute fabric is erected over an area of 160 acres<sup>7</sup>. 'Bisho Ijtema' is an Islamic religious congregation held on the bank of river Turag in Tongi, Gazipur each year. Porous hessian Jute fabric is used as fabric material to shade the area.



Figure 11: Bisholjtema on the bank of river Turag, Tongi, Gazipur.( source: www.thedailystar.net)



Figure 12: Inside view of Bisho Ijtema tent. (Author Rocky S. Hossain, 2010)

#### **References:**

- 1. Brian Forster, Marijke Mollaert; Engineering Fabric Architecture, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 2. Erik Moncrieff, Brian Forster; Glossary, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 3. Jurgen Bradatsch, Peter Patzold, Cristiana Saboia de Freitas, Rudi Scheuermann, Juan Monjo, Marijke Mollaert; Form, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 4. Rabindranath Trivedi, The Durga puja and Minority Rights of Bangladesh, Asian Tribune, 19 October 2012.
- 5. Shireen Akbar, Shamiana: The Mughal Tent, Victoria & Albert Museum, January 1999
- 6. The Divan-i Khass in the Palace in the Delhi Fort,

http://www.bl.uk/onlinegallery/onlineex/apac/addorimss/t/019addor0004694u00000000.html Accessed on 13-11-12

7. All set for Biswa Ijtema from Saturday, The Daily Star, 22 December, 2003

#### Chapter 03:

#### Jute

#### 3.1 Introduction of Jute

Jute is a natural plant. Jute fiber is collected from the bark of the plant and is yellowish golden in color. Jute is called the golden fiber of Bangladesh. Bangladesh is the natural home of best quality Jute. Jute is related with development of economy and poor rural communities in Bangladesh. Jute genome sequencing is decoded by a team of Bangladeshi scientists which opens up huge potentials for Jute development<sup>1</sup>.



Figure 13: Jute plant.Figure 14: Jute collection from field.(source left image http://www.thejutecompany.com/images/juteplant.jpg)(source right image http://media.lonelyplanet.com/lpi/2994/2994-27/681x454.jpg)

Bangladesh is the largest exporter of raw Jute in the world<sup>2</sup>. But export growth of Jute and Jute items has sharply deceased from 1970's<sup>3</sup>. There was a negative growth rate in 80's. The Govt. of Bangladesh has taken initiative to curb the export growth rate of Jute and Jute. For that purpose diversified use of Jute have been motivated and given incentives.

Table 1: Growth Performance of Jute and Jute Goods Export by Bangladesh (reported in Mustafizur Rahman, Nafisa Khaled, 2011)

| Item            | FY1973 – | FY1981 – | FY1991 – | FY2001 – | FY1973 –      |
|-----------------|----------|----------|----------|----------|---------------|
|                 | FY1981   | FY1991   | FY2001   | FY2010   | FY2010        |
| Raw jute        | 1.0      | -1.2     | -1.2     | 13.3     | -0.4          |
| Jute goods      | 9.7      | -1.5     | -1.4     | 6.4      | 0.7           |
| Total raw jute  | 6.8      | -1.4     | -1.4     | 8.3      | 0.4           |
| and jute goods  |          |          |          |          |               |
| Total export    | 10.3     | 9.9      | 13.6     | 12.4     | 10.9          |
| from Bangladesh |          |          |          |          |               |
|                 |          |          |          |          | (in Per cent) |

Jute ranks second only to cotton in amount produced. Traditionally Jute has been used as packing materials such as hessian, sacking, ropes, twines, carpet backing cloth etc. Nowadays Jute is being used in producing of various types of products. Diversified Jute products are being developed such as home textiles, technical textiles, geotextiles, agrotextiles, jute nonwovens, jute reinforced composites, pulp & paper, particle boards, shopping bags, handicrafts, fashion accessories, apparels etc<sup>4</sup>.



Figure 15: Jute fiber extraction (source left image author Shahnewaz Karim, 2011)

(source right image author Auyon , 2011)

Figure 16: Jute fiber is dried in Sun

There are two Jute types in trade white (*Chorchorus capsularis*) and Tossa (*Chorchorus olitorius*). Tossa Jute is softer, silkier, and stronger than white Jute. It is also known as *Paat* in Bangladesh. Jute fiber is collected from the bast or skin of the Jute plant. That's why Jute fiber falls into bast fiber category. Jute plant grows in hot humid rainy alluvial lands. Jute plant is photo reactive, it harvests within 120 days<sup>4</sup>. It grows upto six to ten feet high. Matured Jute plants are cut, tied in bundle and put into slow flowing water for several weeks for fermentation. Jute fibers are pulled off from the bark, washed carefully and then dried in the sun.

Jute has huge ecological benefits. Jute plants purify air by assimilating CO<sub>2</sub>. One hector of Jute plants can absorb 15 MT of carbon dioxide CO<sub>2</sub> and deliver 11 MT of fresh oxygen O<sub>2</sub> during 100days of Jute growing period. Studies reveal that CO<sub>2</sub> absorption rate of Jute is much higher than normal trees. Production of Jute is much less harmful compared to the production of synthetic fibers. Jute cropping enhance soil organic matter through leaf shedding during growing season. Jute cropping can be rotated with other food crops. Jute based multiple cropping enhance agricultural production. Rice, cereals, oilseeds, vegetables are benefitted from Jute cropping. Jute is a biologically efficient plant. Jute grows very fast within 4 to 5 months it matures and yields 8 to 12MT per hectare per annum. Jute requires very little quantity of fertilizer to grow. 7-53kg chemical fertilizers are used per hectare which is insignificant compared to other crops. Jute plant sheds 5-6tons of green leaves per hectare while growing which fertilize the soil<sup>5</sup>.

Jute has thermal insulation properties as it has high specific heat. Ignition temperature of Jute is 193°C. Jute fiber does not melt while charring or burning. Jute has also good resistance to electricity<sup>6</sup>.

There are some disadvantages of Jute, which include poor drapability and crease resistance, brittleness, fiber shedding. Jute fiber becomes yellow in sunlight and decreases mechanical strength, due to the presence of higher lignin contents in Jute<sup>7</sup>. Due to the presence of hemicellulose in Jute fibers, it is hydroscopic. Jute fiber swells on absorption of water, decreasing tenacity of the fiber6. Jute fiber becomes subject to microbial attack in humid climates. Jute fiber strength and durability can be increased various levels through different surface treatments such as alkali treatment, silane treatment, isocyanate treatment, latex coating, permanganate treatment, acetylation, monomer grafting under UV radiation etc<sup>8</sup>.

### 3.2 Properties of Jute.

Jute is a cellulose based material. It is stiff and yellowish in color due to the presence of hemicellulose and lignin. Each Jute fiber is composed of smaller units known as fibrils. They are arranged in right handed spirals and make closely held molecular chains which known as micells<sup>9</sup>. The chemical composition of jute is as follows—

| Alpha Cellulose   | 58-63%                   |
|-------------------|--------------------------|
| Hemicellulose     | 21-24%                   |
| Lignin            | 12-14%                   |
| Pectin            | 0.2-0.5%                 |
| Fat & Wax         | 0.4-0.8%                 |
| Protein           | 0.8-1.5%                 |
| Mineral Materials | 0.6-1.1% (Abdullah 2008) |
|                   |                          |

#### Table 2: Typical Properties of Jute Fiber (Ramaswamy and Aziz 1982)

|  | •          |
|--|------------|
| Fibre length, mm                             | 180 - 800  |
| Fibre diameter, mm                           | 0.10-0.20  |
| Specific gravity                             | 1.02- 1.04 |
| Bulk density, kg/m <sup>3</sup>              | 120 - 140  |
| Ultimate tensile                             | 250 - 350  |
| strength, N/mm <sup>2</sup>                  |            |
| Modulus of elasticity,<br>kN/mm <sup>2</sup> | 26-32      |
| Elongation at break, (%)                     | 2-3        |
| Water absorption, (%)                        | 25-40      |
|  |            |

Jute is relatively stiff and has high strength than other natural fibers.

#### Table 3: Properties of jute fibre in comparison with other fibres (reported in Doan Thi Thu Loan, 2006)

| Fibre   | Density<br>(g/cm3) | Tensile<br>Strength<br>(MPa) | Young's<br>Modulus<br>(GPa) | Elongation<br>At break (%) | Specific Tensile<br>Strength (MPa/<br>g.cm-3) | Specific<br>Young's<br>Modulus<br>(GPa/g.cm-3) |
|---------|--------------------|------------------------------|-----------------------------|----------------------------|---|--|
| Jute    | 1.3-1.45           | 393-773                      | 13-26.5                     | 1.16-1.5                   | 286-562                                       | 9-19   |
| Flax    | 1.5                | 345-1100                     | 27.6                        | 2.7-3.2                    | 230-773                                       | 18   |
| Ramie   | 1.5                | 400-938                      | 61.4-128                    | 1.2-3.8                    | 267-625                                       | 41-85  |
| Sisal   | 1.45               | 468-640                      | 9.4-22.0                    | 3-7                        | 323-441                                       | 6-15   |
| Coir    | 1.15               | 131-175                      | 4-6                         | 15-40                      | 114-152                                       | 3-5  |
| E-glass | 2.5                | 2000-3500                    | 70                          | 2.5                        | 800-1400                                      | 28   |
| S-glass | 2.5                | 4570                         | 86                          | 2.8                        | 1828  | 34   |

1. Mudassir Rashid, "Bangladesh decoded Jute's genome sequencing 'Golden fiber to redeem the lost glory'", Bangladesh Textile Today, Jul-Aug 2010.

2. World Export report of raw Jute, Kenaf and allied fibers from 2003/2004 to 2009/2010, Food and Agriculture Organization (FAO)

3. Mustafizur Rahman, Nafisa Khaled "Global Market Opportunities In Export of Jute", CPD, 2011, Dhaka

4. Dr A.B.M. Abdullah,"Jute Geotextiles and Their Applications", Jute Diversification Promotion Centre (JDPC), Dhaka, June 2008.

5. "Environmental Impact of Jute Agriculture", International Jute Study Group (IJSG), http://www.jute.org/ecology.htm accessed on 14-11-12

#### 3.3 Jute Fabrics

Different types of Jute fabrics are manufactured in in spinning and composite mills with conventional spinning and looms. Depending on drafts, twists, dollop weight, design such as plain, twill, basket, satin/steen with closed, dense and open structure wide range of fabrics can be produced with different strength, thickness, porosity and permeability. Composite types of fabrics such as Jute-cotton union fabric are also produced with different ratio.



Figure 20: Jute Double Warp (D.W.)

Figure 20: 50:50 Jute-cotton union

Following Jute fabrics are commonly used and available in market hessian, canvas, D.W twill, Jute-cotton blend. Hessian is the most porous; canvas is very closely woven with flat type yarn and least porous. Double warp (D.W.) twill is also known as A-twill, which is a 2/1 twill weighing 750 g/m<sup>2</sup> and widely used for packaging purposes<sup>10</sup>.

### 3.3.1 Jute Geotextiles (JGT)

High strength Jute fabrics are now used as geotextiles. Jute geotextiles (JGT) are applied in various civil engineering projects. For example Rokeya shoroni link road was constructed in December 2008 in Dhaka<sup>11</sup>. Jute geotextiles are now becoming strong alternative to synthetic geotextiles. Though Jute geotextiles (JGT) are quickly biodegradable, but their life span can be extended up to 20yrs through proper treatment and blendings<sup>12</sup>. JGTs are anionic, harmless, and soil fertilizer. They are used in different purposes such as erosion control, soil filtration and drainage, soil stabilization and fertilization etc. A comparison is presented in the table between various types of untreated, bitumen treated JGT and synthetic geotextiles.

|         |           | -         |           |          | •        | •••        | •        |            | •        |
|---------|-----------|-----------|-----------|----------|----------|------------|----------|------------|----------|
| Product | Condition | Mass per  | Thickness | Wide     | Grab     | CBR        | Burst    | Permitivit | AOS (mm) |
|         |           | unit area | (mm)      | width    | tensile  | puncture   | strength | У          |          |
|         |           | (g/m2)    |           | tensile  | strength | resistance | (kPa)    | (S—1)      |          |
|         |           |           |           | strength | (N)      | (N)        |          |            |          |
|         |           |           |           | (kN/m)   | MD/XMD   |            |          |            |          |
| Jute    | Treated   | 1600      | 3.5       | 15/18    | 800/700  | 4000       | 1500     | 0.06       | 0.0 to   |
|         | Untreated | 800       | 2.8       | 10/12    | 400/220  | 1500       | 1250     | 0.28       | 0.28     |
| C       | Turneted  | 1200      | 2.5       | 27/45    | 1100/700 | 1000       | 1000*    | 0.0        | 0.0.4.5  |

Table 4: Test result of treated JGT, untreated JGT and synthetic geotextiles (reported by Jabbar, 2008)

|           | Untreated   | 500     | 1.3     | 23/14    | 850/400  | 1700  | 2400  | 0.03    | 0.09   |
|-----------|-------------|---------|---------|----------|----------|-------|-------|---------|--------|
| DW Twill  | Treated     | 1400    | 3.1     | 25/32    | 1000/900 | 1700* | 2600  | 0.21    | <0.075 |
|           | Untreated   | 750     | 2.4     | 23/26    | 900/750  | 4500  | 2400  | 0.25    | 0.8    |
| Hessian   | Untreated   | 300     | 1.5     | 12/14    | 210/220  | 1500  | 1400  | 1.19    | 1.0    |
| Synthetic | Non-Woven   | 240-640 | 2.0-4.5 | [18-48]  | [1160-   | 2660- | 3800- | 0.4-1.8 |        |
|           | Geotextiles |         |         | /[15-31] | 2590]    | 5450  | 4500  |         |        |

- 6. Tapobrata Sanyal, "Jute & Jute Geotextiles", http://www.jute.com:8080/c/document\_library/get\_file?uuid=87c9f7ad-ddc6-4b36-9cae-ecf4edd456ec&groupId=22165 Accessed on 14-11-2012
- 7. Capucine Korenberg, "The effect of ultraviolet-filtered light on the mechanical strength of fabrics", The British Museum Technical Research Bulletin, Volum 1 2007.
- 8. Doan Thi Thu Loan, "Investigation on Jute fibers and their composites based on polypropylene and epoxy matrices", Technischen Universität Dresden, May 2006.
- 9. Md. Milon Hossain, Rumpa Karmaker, Sudipta Bain, M. A. Jalil and Joykrishna Saha, "Investigation of Influence of Twill Structures on Jute-Cotton Union Fabric Physical Properties", IJASETR, Volume 1, Issue 2, Article #06, April 2012

#### 3.3.2 Jute-Cotton Union fabrics

In Jute-cotton union fabric, cotton yarn is normally used in warp direction and Jute is used in weft direction. Jute-cotton union fabrics are cheaper than 100% cotton fabric because of Jute in it. It has a great potential to replace 100% cotton fabric. Jute-cotton union fabrics are now used as carpets, rugs, floor covering.

#### 3.4 Strength Test

For tensile strength testing purposes, one side Polypropylene (PP) laminated untreated hessian Jute 13x13, 15x15 and 50:50 Jute-cotton union fabric have been collected from Jute Diversification Promotion Center (JDPC) Dhaka. And they have been tested in Geotech Lab of Dept. of Civil Engineering, Bangladesh University of Engineering & Technology. Strip tensile strength was done according to ASTM D4595. Report is attached in appendices.



Figure 23: One side laminated (13x13) Jute-fabric Figure 23: 50:50 Jute-cotton blend



Figure 23: One side laminated (15x15) Jute-fabric

Table 5: Tensile strength test result

| Fabric         | Chemical  | Weave        | Average   | Yarn     | Thickness, | Strip tensile | Strip tensile |
|----------------|-----------|--------------|-----------|----------|------------|---------------|---------------|
| sample         | treatment | construction | mass per  | count    | mm         | strength      | elongation    |
|                |           |              | unit area | Jute tex |            | MD/XMD        | MD/XMD %      |
|                |           |              | gm/m2     |          |            | kN/m          |               |
| (13x13) Jute   | untreated | Plain weave  | 376       | 256      | .88        | 15.4/16.7     | 10/10         |
| fabric natural |           |              |           |          |            |               |               |
| (15x15) Jute   | untreated | Plain weave  | 331       | 150      | .756       | 14/12         | 12/8          |
| fabric natural |           |              |           |          |            |               |               |
| Jute-Cotton    | untreated | Plain weave  | 2213      | 95       | 1.025      | 18.1/15.2     | 4/22          |
| 50:50 union    |           |              |           |          |            |               |               |

From the strength test it is found that one side laminated (13x13) Jute fabric has more tensile strength than (15x15) Jute fabric. Tensile strength of Jute-cotton fabric is the highest among three fabrics, since it has cotton in it.

. . . . . . . . . . . . . . .

(15x15) Jute fabric has more elongation in MD than (13x13) Jute fabric but less elongation in XMD direction. On the other hand Jute-cotton fabric elongation in XMD is the highest and in MD is the lowest, because of the use Jute in XMD direction and cotton in MD direction. Jute-cotton union fabric has the highest mass per unit area and thickness among the three fabric tested.

- 10. Jute products: sacking, http://www.jute.org/jute\_prod\_sac.htm accessed on 16-11-12
- 11. Prof. Dr. Abdul Jabbar Khan, Major Md Masudur Rahman, "A JGT Reinforced Road Subgrade In Bangladesh", http://www.fibre2fashion.com/industryarticle/21/2028/a-jgt-reinforced-road-subgrade-in-bangladesh1.asp accessed on 14-11-12
- 12. Dr A.B.M. Abdullah," Jute Geotextiles and Their Applications", Jute Diversification Promotion Centre (JDPC), Dhaka, June 2008.

#### 3.5 Cost Comparison

Cost comparison of laminated Jute, Jute-cotton union fabric, Canvas, DW twill in €/m<sup>2</sup> is given below.



Table 6: Recent market cost comparison of different Jute fabrics €/m<sup>2</sup>

From the above chart we can see that cost of Type I PES is almost 14 times higher than one side laminated Jute 13x13 in local market, because of the local production and availability of Jute fabric. Prices of Jute fabrics are collected from JDPC (Jute Diversification and Promotion Center) of BJRI (Bangladesh Jute Research Institute).

#### 3.6 Review of Recent Research and Developments

Diverse Jute based products are now produced. New researches and technologies are being developed to enhance the quality of Jute products. Some recent research and developments in this field are mentioned below.

A group of Bangladeshi scientists led by Dr. Prof. Dr. Maqsudul Alam have successfully disclosed Jute genome sequencing. It is a great leap for Jute development. Jute plants are affected by flood, saline soil and different types of pest and diseases that harm cultivation. By developing Jute genome it is possible to develop high yielding, flood resistant, saline soil and pest tolerant Jute.

Jute is now used in housing sector, replacing traditional material. Research group of Bangladesh Atomic Energy Commission (BAEC) has developed JUTIN, which is produced from jute (hessian cloth), and resin. JUTIN is durable, rustproof, saline-resistant, lightweight, heat-resistant, and environment friendly. It is 40.2% cheaper than existing alternatives. It may replace traditional corrugated iron (CI) sheets. JUTIN will play a major role in housing sector of Bangladesh<sup>13</sup>.



Figure 24: Jutin (Md Saimum Hossain, Energy Efficient and Low cost Housing Material, 2010)

#### Figure 24: Jutin (Ivid Salmum Hossain, Energy Efficient and Low-cost Housing Material, 2010)

Jute fiber is also used in ecofriendly boat making. A 9m long eco-friendly boat ecofriendly boat made of 40% jute and 60% fiber glass is built Taratari shipyard near Dhaka. It is designed by French naval architect Marc Van. Corentin de Chatelperron set sail on this boat from Bangladesh to France in September 2010<sup>14</sup>.

Due to biodegradability of Jute, durability of Jute products is short. But recent study show that latex treated Jute can last upto 20yrs<sup>15</sup>.

- 13. "Local researchers develop jute-made substitute for CI sheet", http://www.thefinancialexpress-bd.com/more.php?news\_id=97298&date=2010-04-10 accessed on 14-11-12
- 14. http://tibotaratari.wordpress.com/2010/09/15/taratari-corentin-voiles-et-voiliers-video/ accessed on 14-11-12
- 15. Dr. A. B. Jabbar Khan, "Quality Control of Jute Geotextiles & Development of Testing Facilities", http://www.jute.com:8080/c/document\_library/get\_file?uuid=f1d0dc40-69a9-490c-89c8-ca05dede6918&groupId=22165 accessed on 14-11-12

| Туре   | Composition                            | Poss. durability | Biodegradability | Moisture<br>content | Wt./unit gm |
|--|--|------------------|------------------|---------------------|-------------|
| Woven Jute in<br>different structure/<br>design    | All Jute<br>(untreated)                | 6-9 month        | Quick            | 12-14%              | 220-800     |
| Woven Jute in<br>different design/<br>Construction | Jute treated with coir                 | 9-12 month       | Slow             | 7-10%               | 220-800     |
| Woven Jute but<br>treated composite                | Jute treated<br>with Bitumin<br>carbon | 9-48 month       | Long run         | 3-8%                | Var. wt.    |
| Woven Jute in<br>different Construction/<br>design | Jute treated<br>with Latex             | 5-20 years       | Long run         | 5-7%                | ≥ 800       |

Table 7: Summary of jute blended with different materials at BJRI (reported in Jabbar, 2008)

Jute fiber becomes brittle and loses its strength in prolonged exposure to sun. To protect it from UV radiation several treatments and dyes have been developed. One example is monochlorotriazinyl reactive dye with cyanuric chloride nucleus, such as Cibacron Red FAL which is found to be effective in UV protection. Simultaneous dyeing and finishing with Cibacron Red FAL and Cibatex UPF provides higher UV protection. The treatment of jute/cotton fabric with titanium dioxide also provides satisfactory protection against UV rays<sup>16</sup>.

Due to hydroscopic behavior of Jute, it attracts water. Water uptake can significantly reduce tenacity. Water uptake of Jute fiber can be significantly reduced through treating fiber surfaces by NaOH/(3-Aminopropyl-triethoxy-silane + Epoxy dispersion XB 3791) and NaOH/3-Phenylaminopropyl-trimethoxy-silane<sup>17</sup>.

There is a growing interest on Jute reinforced polymer matrix composites, due to ecological aspects of Jute such as biodegradability, renewability, low energy, non-toxic, non-health hazardous as well as good thermal and electrical insulations, toughness, and market availability at low cost. Jute polymer composites such as Jute fiber reinforced polypropylene or epoxy, Jute-glass fiber hybrid composite, Jute fabric-Reinforced PVC-based composite, Jute viscose/polyester and cotton blended fabric, jute fabric-reinforced polyester composites are now used as panels, false ceiling, partition boards, wall, floor, window and door frames, roof tiles, furniture, electric devices, automobile and railway coach interior, boat, Toys etc.

A green Architectural membrane, based on Kenaf bast fiber has been developed by Taiyo Kogyo Crop. Kenaf is a natural fiber and have similar characters as Jute. Kenafine<sup>TM</sup>, developed by Taiyo Kogyo Crop., is made by weaving Kenaf fiber with polyester fiber. This bas fabric is coated on top with photocatalyst  $TiO_2$  and at bottom coated with antibacterial agent of silver. This environment friendly green membrane can be recycled to make paper product<sup>18</sup>. Thus it is a carbon-neutral product than 100% polyester based fabrics. Test result of Kenafine is given below.





Figure 25: Kenaf plant. (source http://fabricarchitecturemag.com/repository/4/15396/full\_1112\_np9\_1.jpg)

- 16. Ghosh S. B., Bajaj P., Kothari V. K. "Effect of dyes and finishes on UV protection of jute/cotton fabrics", Indian journal of fibre & textile research, vol. 28, no4, pp. 431-436, 2003
- 17. Doan Thi Thu Loan, "Investigation on Jute fibers and their composites based on polypropylene and epoxy matrices", page-112, Technischen Universität Dresden, May 2006.

| Items  | Test method  | Measurement value |
|--|--|-------------------|
| Mass (g/m²)  | ЛЅ К 6404-2-2<br>ISO 2286-2                            | 904               |
| Thickness (mm)   | ЛЅ К6404-2-3   | 0.82              |
| Flame retardancy   | NFPA 701   | M2(pass)          |
| Flame retardancy   | ЛS A 1322 method B                                     | grade2 (pass)     |
| Tensile strength (N/3cm)                                     | ЛS L 1096  | 2470 x 2340       |
| Tensile strength (N/5cm)                                     | ISO 1421   | 3979 x 3734       |
| Lap joint of tensile strength (%)                            | JIS L 1096   | 100               |
| Tear strength (N)  | ЛS L 1096  | 229.6 x 271.7     |
| Tear strength (N/mm)   | DIN 53363  | 355 x 427         |
| Tear strength (N)  | ASTM D 751-06  | 156.1 x 193.8     |
| Resistance to accelerated and outdoor<br>exposure weathering | After UV irradiance for 416h                           | 98 x 87           |
| Decomposition activity index<br>(nmol/L/min)                 | ЛS R1703-2<br>Decomposition of wet methylene<br>blue   | 20.9              |
| Antibacterial activity                                       | ЛS Z 2801<br>Staphylococcus aureus<br>Escherichia coli | >5.0<br>>6.0      |

Table 8: Test result of Kenafine<sup>TM</sup>

(Source http://fabricarchitecturemag.com/articles/1112\_np9\_material\_research.html)



Figure 26: Structure of Kenafine<sup>™</sup> (Source http://fabricarchitecturemag.com/articles/1112\_np9\_material\_research.html)

18. H. Toyoda, "Recyclable coated fabric using kenaf fiber for architectural membrane structure applications", Fabric Architecture, November 2012, http://fabricarchitecturemag.com/articles/1112\_wp\_kenaf\_fiber.html accessed on 16-11-12.

#### Chapter 04:

#### **Design development**

#### 4.1 Project background

Dhaka Zoo is situated in north eastern part of Dhaka. It was established in June 1974. It is the largest zoo in Bangladesh. It has an area of 75.53 hector with north and south lakes<sup>1</sup>. Dhaka zoo holds 4th position in the world considering the land area of other zoos<sup>2</sup>. About 4 million visitors visit Dhaka zoo each year<sup>1</sup>. It is operated by Ministry of Fisheries and Livestock. To raise the standard of the zoo to an international level Ministry has taken initiatives for renewal and redevelopment plan for Dhaka zoo. Ministry is sponsoring Dhaka zoo modernization project from July 2010 to June 2015. It will be executed by Department of Livestock Services. The modernization project includes construction of 20 new visitor's shed in Dhaka zoo with an area of 25 sqm for each<sup>3</sup>.



Figure 27: Dhaka zoo satellite image. Source: Google earth



Figure 28: Existing visitor's shed in Dhaka zoo.

#### 4.1.1 Project Requirement

20 visitors's shed design in Dhaka zoo. Area of each shed will be approx. 25sqm.

#### 4.1.2 Site Description

Site locations for proposed visitor's sheds have been identified based on their locations, which are close to walkaways, lakes and cases.



Figure 29: Site location for a prototype visitor's shed.

#### References:

- 1. History of Dhaka zoo, http://www.dhakazoo.org/history.html accessed on 13-11-12
- 2. BUET finalises clauses for zoo renovation master plan, Dilara Hossain, Bangladesh Sangbad Sangstha (BSS), 6 April 2012.
- 3. Dhaka & Rangpur Zoo Modernization Project, Development Project Proposal (DPP), Ministry of Fisheries and Livestock, July 2010

#### 4.2 Conceptual Development

A prototype shed is developed which can be repeated in various sites with minor changes. Several ideas are sketched. Simplicity, lightweight structure, attractive sculptural quality and functionality are considered while designing visitors shed.



Figure 30: Some sketches of design development phases

A simple sculptural light form has been developed which gives good shadow. The fabric is supported mainly by two high masts, two low masts and cables. Masts are connected by safety cables. At the low points water will be collected and collection points will be designed.



Figure 31: Perspective view



Figure 33: South Elevation



Figure 34: West Elevation

# 4.3 Physical Model Study

A physical model 1:50 scale has been made to study the surface shape, though achieving good shape is time consuming and laborious. It was made using cotton vest fabric, bamboo sticks and polyester thread.





Figure 35: Physical model scale 1:50

#### 4.4 Formfinding

Formfinding is a unique process for tensile membrane structures compared to traditional structures. It is finding basic static surface geometry of a tensile membrane structure within a given boundary configuration, before detail structural analysis. Concept of formfinding is based on 'minimal surface'. With minimal surface potential energy is a minimum, the shape configuration is stable. The ideal example of minimal surface with constant surface stress in nature is soap-films<sup>4</sup>. Because of the minimal shape any discontinuity or lack of tension will produce wrinkling, deformation and reduce life expectancy<sup>5</sup>.

Numerical formfinding of the proposed structure was done by ixForten4000<sup>6</sup> software and boundary was drawn in Rhino<sup>7</sup>. A Jute fabric material is created in ixForten4000 using tensile strength 16.7kN/m in warp and 15.4kN/m in weft with elongation 10% in warp and weft which is based on test result in BRTC, BUET lab. Materials and properties of different elements during formfinding are given below.

|               |              | Tesnso Group  |            | Membrane       |                |  |
|---------------|--------------|---------------|------------|----------------|----------------|--|
|               | Stay cables  | Safety cables | Mast       | Fabric         | Edge cables    |  |
| C values      | NA           | NA            | NA         | 0.7            | 1.4-0.7        |  |
| Seed          | cable 16     | cable 6       | R100t13    | Jute fabric    | cable6         |  |
| Material      | Steel Cables | Steel Cables  | S235       |                | Steel Cables   |  |
| Туре          | Cable        | Cable         | Truss      | Membrane       | Cable          |  |
|               | NL-          | NL-           | NL-        |                |                |  |
| Deformability | Deformable   | Deformable    | Deformable | FDM-Deformable | FDM-Deformable |  |
| Behavior      | Non-Linear   | Non-Linear    | Non-Linear | Non-Linear     | Non-Linear     |  |

 Table 9: Properties of different elements in formfinding



Figure 36: S-11 stresses after formfinding

- 4. W J Lewis, Tension structures: Form and Behavior, Thomas Telford, London, 2003
- 5. Jurgen Bradatsch, Peter Patzold, Cristiana Saboia de Freitas, Rudi Scheuermann, Juan Monjo, Marijke Mollaert, Form, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 6. ixForten4000 version R 4.2.6, developed and copyrighted by Gerry D'Anza
- 7. Rhinoceros 4, Education version, developed and copyrighted by Robert McNeel and Associates

Overall sigma 11 stress, after formfinding is found to be 1.47 kN/m. Stress in corners is higher. Sigma 22 stresses are comparatively lower than sigma 11 stresses.



Figure 37: Sigma 22 stresses after formfinding

#### 4.5 Shadow study

Shadow study has been made using Google Sketchup<sup>8</sup>. Geo location has been entered for Dhaka 23.7000° North, 90.3833° East. Since Dhaka is situated in tropic of cancer summer solstice June 21 is chosen to study shadow. During this period temperature is relatively higher and shadow becomes smaller. Shadows are studied for each hour from 8am to 4pm and juxtaposed to see the shadow patterns.



Figure 38: Juxtaposed shadows from 8am to 4pm

#### 4.6 Membrane analysis

Non-Linear analysis of the membrane using different load combinations was done using ixForten4000<sup>6</sup>.

#### 4.6.1. Wind Load

Dhaka Zoo is located in Northwest part of Dhaka. Latitude and longitude of Dhaka is 23.7 and 90.38 respectively. Average annual wind flow is 2<sup>8</sup> (Beaufort scale). But Dhaka often experiences storms. Storms with 50-60 km/h are most frequent<sup>9</sup>. Basic wind speed 22.6 or Beaufort scale 9 is considered for the proposed membrane structure.

Basic wind speed V<sub>b</sub>=22.6 m/s

Resulting wind pressure  $q_b = \frac{Vb^2}{1600} \text{ kN/m}^2 = 0.32 \text{ KN/m}^2$ 

According to eq. 4.8 of Eurocode 1991-1-4: Wind loads, Peak velocity pressure  $q_p(z) = c(z)^*q_p$ For a height (z) of 6m and terrain category III or suburban settings the exposure factor c (z) is 1.3 Then the peak velocity pressure  $q_p(z) = 0.42$  KN/m<sup>2</sup>

According to eq. 5.1 of Eurocode 1991-1-4: Wind loads, Wind pressure on surfaces  $w_e = q_p(z) * c_{pe}$ Where,  $c_{pe}$  is external pressure coefficient. Pressure coefficient  $c_{pe}$  has been determined according to European Design Guide for saddle structure.

|       | Сре    | Wind pressure KN/m2 | Resulting pressure KN/m2 |
|-------|--------|---------------------|--------------------------|
| Zones | values |                     |                          |
| А     | 1.45   | 0.42                | 0.61                     |
| В     | 0.90   | 0.42                | 0.38                     |
| С     | 0.95   | 0.42                | 0.40                     |
| D     | 1.00   | 0.42                | 0.42                     |
| E     | 1.50   | 0.42                | 0.63                     |
| F     | 1.80   | 0.42                | 0.76                     |
| G     | 1.20   | 0.42                | 0.50                     |
| Н     | 1.10   | 0.42                | 0.46                     |
| I     | 1.20   | 0.42                | 0.50                     |
| J     | 0.65   | 0.42                | 0.27                     |
| К     | 0.85   | 0.42                | 0.36                     |

#### Table 10: Pressure coefficients for proposed membrane structure





Figure 39: Cp Zone definitions for wind X direction

- 8. http://www.dhaka.climatemps.com/ accessed on 6-12-12
- 9. Samarendra Karmakar, Md. Mahbub Alam, Development Of Statistical Techniques For The Forecasting Of Nor'westers And Associated Maximum Gusty Wind And Rainfall Over Bangladesh, Journal of Bangladesh Academy of Sciences, Vol. 35, No. 2, 125-140, 2011



Figure 40: Cp Zone definitions for wind Y direction

#### 4.6.2. Snow Load

Since there is no snow in Dhaka, therefore no snow load is considered.

#### 4.6.3. Load Combinations

Load combinations are assumed according to DIN EN 1990

SLS SLS-01: 1.0g+1.0v<sub>0</sub> SLS-02: 1.0g+1.0v<sub>0</sub>+1.0w SLS-03: 1.0g+1.0 v<sub>0</sub>+1.0w+1.0s ULS ULS-01: 1.35g+1.35v<sub>0</sub> ULS-02: 1.35g+1.35v<sub>0</sub>+1.5w ULS-03: 1.35g+1.35v<sub>0</sub>+1.35w+1.35s

Where, g = self-weight v<sub>0</sub> = prestress w = wind load (acting downwards or uplift) s = snow load

In Serviceability Limit State (SLS) structure remains functional for its intended use under routine conditions or everyday use. In Ultimate Limit State (ULS) structure will not collapse, buckle or twist when it is subjected to maximum design load<sup>10</sup>.

| SLS    |        |        |        |  |  |  |  |  |
|--------|--------|--------|--------|--|--|--|--|--|
|        | Self-  |        |        |  |  |  |  |  |
|        | weight | Wind X | Wind Y |  |  |  |  |  |
| SLS 01 | 1      | 0      | 0      |  |  |  |  |  |
| SLS 02 | 1      | 1      | 0      |  |  |  |  |  |

| SLS 03 | 1 | 0 | 1 |
|--------|---|---|---|
|--------|---|---|---|

| ULS    |        |        |        |  |  |  |  |  |  |
|--------|--------|--------|--------|--|--|--|--|--|--|
|        | Self-  |        |        |  |  |  |  |  |  |
|        | weight | Wind X | Wind Y |  |  |  |  |  |  |
| ULS 01 | 1.35   | 0      | 0      |  |  |  |  |  |  |
| ULS 02 | 1.35   | 1.5    | 0      |  |  |  |  |  |  |
| ULS 03 | 1.35   | 0      | 1.5    |  |  |  |  |  |  |

10. Prof Dr.-Ing. Lars Schiemann, Dr.-Ing. Karsten Moritz, Structural Design Concepts, IMS, September 2011

#### 4.6.4. Maximum Stress and Membrane Selection

Maximum overall stress is found 4.45 KN/m in loadcase ULS03. Maximum stress 12.07 KN/m is located in corner where double layer of membrane is required.



Figure 41: S-11 stress in loadcase ULS-3

Strength of the membrane degrades due to environmental conditions, temp., age, joining methods, creasing etc. Reduction factors for membrane material according to DIN 4134

|           |                | A fac          | Resulting reduction factor |                |                  |
|-----------|----------------|----------------|----------------------------|----------------|------------------|
| Loads     | A <sub>0</sub> | A <sub>1</sub> | A <sub>2</sub>             | A <sub>3</sub> | A <sub>res</sub> |
| Permanent | 1.2            | 1.6            | 1.2                        | 1.2            | 2.76             |
| Wind      | 1.2            |                | 2 1.2                      |                | 1.44             |

Material safety factor for membrane Y<sub>m</sub>=1.4

Then allowable strength  $f_d = f_{tk} / (Y_m x A_{res})$ 

Where  $f_{tk}$ = Tensile strength of the membrane

Allowable tensile strength of the laminated Jute membrane for permanent load

| Direction | Tensile strength<br>KN/m | Safety factor<br>γm | Reduction factor<br>Ares Prestress | Allowable strength<br>KN/m |
|-----------|--------------------------|---------------------|------------------------------------|----------------------------|
| Warp      | 16.7                     | 1.4                 | 2.94                               | 4.1                        |
| Weft      | 15.4                     | 1.4                 | 2.94                               | 3.7                        |

Which is ok, since overall stress after formfinding is 1.47KN/m

Allowable tensile strength of the laminated Jute membrane for wind load

| Direction | Tensile strength<br>KN/m | Safety factor<br>γm | Reduction factor<br>Ares wind | Allowable strength<br>KN/m |
|-----------|--------------------------|---------------------|-------------------------------|----------------------------|
| Warp      | 16.7                     | 1.4                 | 1.44                          | 8.3                        |
| Weft      | 15.4                     | 1.4                 | 1.44                          | 7.6                        |

Which is ok, since overall maximum stress found in loadcase ULS03 is 4.45KN/m.

So the laminated Jute fabric which has been selected as membrane material can withstand wind load and permanent load.

4.6.5. Displacement of The Membrane

There is a displacement of 28.73cm is found in loadcase SLS02. But no ponding area has been observed.



Figure 42: Displacement in loadcase SLS02

There is a displacement of 36.25cm is found in loadcase SLS03. But no ponding area has been observed.



Figure 43: Displacement in loadcase SLS03

4.7 Patterning

To fabricate the membrane using 1.32m wide Jute 13x13 fabric, geodesic cutting lines are introduced on the surface of the membrane considering curvature of the surface, main load carrying paths, aesthetic reasons, fabric width. For avoiding wrinkling, material economy and accuracy geodesic cutting lines are generated on the surface of the membrane using ixForten4000. Geodesic lines on a curved surface are equivalent to straight lines on a plane. (Bletzinger 2008)

Patterns are made aligning warp of the fabric in hanging direction to take dynamic wind load while weft in arching direction. There are nineteen patterns ranging from 0.12m to 1.17m in width and 0.51m to 5.45m in length. A compensation of 0.3% corresponding test result has been taken into account in warp and weft.





Figure 45: East View



Figure 46: South view





Since Jute 13x13 fabric is not weldable, double backing run stitched seam is introduced. To protect seam from water penetration, water proof UV stabilized polyethylene transparent tape is used to cover seams.



Figure 48: Section AA



Figure 49: Section CC



DOUBLE BACKING RUN STITCHED SEAM

Figure 50: Section BB

Patterns are nested on 1.32m wide Jute 13x13 fabric. Minimisation of the fabric has been considered while nesting



Figure 51: Single pattern



Figure 52: Nesting of the patterns on the Jute 13x13 fabric

### 4.8 Detail Design

Detail design is an important feature for a membrane structure. Detailing not only helps to flow forces through structural systems easily, but also through detailing beauty and elegance of a structure can be expressed.

#### 4.8.1. Cable dimensioning

Dimensioning of the cables is given below.



Figure 53: Edge cables

| Cable    | Maximum | Cable  | Cable | Cable    | Characteristic | Safety | Material | Limit         |
|----------|---------|--------|-------|----------|----------------|--------|----------|---------------|
| Position | force   | Length | type  | diameter | breaking load  | factor | Safety   | Tension       |
|          | Fd kN   | m      |       | mm       | Fuk <b>kN</b>  | γr     | Factor   | FRd <b>kN</b> |
|          |         |        |       |          |                |        | γm       |               |
| E01      | 10.153  | 5.56   | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8          |
| E02      | 2.901   | 4.1    | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8          |
| E03      | 2.127   | 3.9    | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8          |



#### Table 12: Stay cables

| Cable    | Maximum | Cable  | Cable | Cable    | Characteristic | Safety | Material | Limit   |
|----------|---------|--------|-------|----------|----------------|--------|----------|---------|
| Position | force   | Length | type  | diameter | breaking load  | factor | Safety   | Tension |
|          | Fd kN   | m      |       | mm       | Fuk kN         | γR     | Factor   | FRd kN  |
|          |         |        |       |          |                |        | γm       |         |
| A/B      | 9.8     | 7.4    | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8    |
| C/D      | 10.23   | 4      | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8    |
| E/F      | 5.23    | 2      | PE03  | 6.1      | 26             | 1.1    | 1.5      | 15.8    |

Length of the safety cable S01 is 7.6m and S02 is 6.7m. Cable type for the safety cables is PE03 and diameter is 6.1mm.

#### 4.8.2. Membrane Corner Design

To transfer forces from cables and tangential forces from doubly curved membrane surface corner plates are designed. Minor adjustment and fine tuning can be done through nut and turnbuckle. There are three types of corner plates CP01, CP02, CP03. Location of these corner plates shown below



Figure 56: Corner Plate CP01 detail



Figure 58: Corner Plate CP03 detail
### 4.8.3. Connection Design

Connections are designed in a way to facilitate flexibility and displacement of the membrane structure under dynamic conditions. Connections with mast 01 and mast 02 are given below.



Figure 59: Connection with Mast01



## 4.8.4. Masts design

Mast has been designed according to AISC/LRFD method. Mast01 and mast02 is made of A36 steel. Mast01 is 5.9m long and 89.1mm in diameter 2.5mm thick. Mast02 is 3.4m long and 60.3mm in diameter 2.0mm thick. Detail calculation has been provided in appendices.





#### 4.8.5. Anchorage design

Light foundation is designed to prevent wind uplift and to facilitate connection of masts and stay cables to the ground. Detail of the foundation is provided in appendices.



Figure 63: Foundation layout





#### Chapter 05:

#### Fabrication

#### 5.1 Cost Estimation

Estimation of the cost is based on local market price. Estimation is given below.

#### STATISTICAL VALUES

all values are given to the surface of the construction -x/SUR

| Confection M                         | cost confection /m <sup>2</sup> SUR | €/m2        | 13.60          |
|--------------------------------------|-------------------------------------|-------------|----------------|
| Steel Weight total<br>STAHL          |                                     | kg<br>kg/m² | 132.00<br>3.52 |
| Total cost without planning and VAT  |                                     | €/m²        | 87.61          |
| Overall cost including 10% General C | contractor                          | €/m2        | 251.42         |
| STATISTICAL VALUE PLANNING           | Planning /m2                        | €/m2        | 26.28          |
|                                      |                                     | %           | 30             |

#### **Statistical Values in % of the Membrane Project**

| <i>without approva</i><br>total Sum in € | l cost and On site tasks  | 7071 € |   |        |
|--|---------------------------|--------|---|--------|
| 1.                                       | MEMBRANE                  |        |   |        |
| 2.                                       | STEEL                     | 510    | € | 7.21%  |
| 3.                                       | CABLES                    | 697    | € | 9.86%  |
| 4.                                       | TRANSPORT                 | 1,383  | € | 19.56% |
| 5.                                       | FOUNDATION                | 300    | € | 4.24%  |
| 6.                                       | ERECTION                  | 2,800  | € | 39.6%  |
| _  |                           | 395    | € | 5.6%   |
| 7.                                       | PLANNING COST ENGINEERING | 985.61 | € | 14%    |

From the statistical values of cost calculation, it can be seen that because of using Jute fabric cost of membrane is only around 7.21%. Around 50% of the cost is spent on transportation, foundation and erection process. Cost of steel masts and cables are around 30%. Consultation and planning will cost 14%.

#### 5.2 Time Schedule

The purpose of time schedule is to reduce time wastage as well as enhance work efficiency. It clarifies working steps and links different steps until completion of a project. The time schedule for the membrane cover for visitor shed in Dhaka zoo comprises 19 steps from concept preparation to handover. Approximately 12 weeks will require upto the handover of the project.



|                        | -                                     |   |                   |  |          |   |     |             |   |          |
|------------------------|---------------------------------------|---|-------------------|--|----------|---|-----|-------------|---|----------|
| 15                     | Foundation Construct                  | ion 7 days                              | Wed 5/8/13 Thu 5  | /16/13 8   |          |   |     |             |   |          |
| 16                     | Deliveries                            | 1 day                                   | Sun 5/12/13 Sun 5 | /12/13 13  |          |   |     |             |   | <b>1</b> |
| 17                     | Steel Erection                        | 1 day                                   | Mon 5/13/13 Mon 5 | 5/13/13 16                                       |          |   |     |             |   | ĭ_ ∣     |
| 18                     | Rope/ Membrane Ere                    | ction 1 day                             | Tue 5/14/13 Tue 5 | /14/13 17  |          |   |     |             |   | ŭ        |
| 19                     | Handover/ Acceptenc                   | e 1 day                                 | Wed 5/15/13 Wed 9 | 5/15/13 18                                       |          |   |     |             |   | ă        |
|                        |                                       |   |                   |  |          |   |     |             |   |          |
|                        |                                       | Task                                    |                   | External Tasks                                   |          | Manual Task   | c ) | Finish-only | 3 |          |
|                        |                                       | Solit                                   |                   | . External Mileston                              | ie III 🔶 | Duration-only   |     | Deadline    |   |          |
|                        |                                       | Spire                                   |                   | Enternarineston                                  |          | Duradon only  |     | Deadline    | • |          |
| Project: Me            | Membrane Cover in Ethio               | Milestone                               | •                 | Inactive Task                                    |          | Manual Summary Rollup                                 |     | Progress    | • | -        |
| Project: M<br>Date: We | Membrane Cover in Ethio<br>ed 2/20/13 | Milestone<br>Summary                    | ÷                 | Inactive Task                                    | e \$     | Manual Summary Rollup<br>Manual Summary               |     | Progress    |   | -        |
| Project: N<br>Date: We | Membrane Cover in Ethio<br>ed 2/20/13 | Milestone<br>Summary<br>Project Summary | ÷                 | Inactive Task Inactive Mileston Inactive Summary | e ¢      | Manual Summary Rollup<br>Manual Summary<br>Start-only |     | Progress    |   | -        |

Figure 66: Time schedule

#### 5.3 Erection procedure

Erection process consists of different activities it include unloading of the material, site set-up, erection preparation, preassembly, lifting, hanging and preassembly<sup>1</sup>.

Erection procedure will follow three steps. First step begins with setting up the membrane with masts and insertion of edge cables into the pockets. The unpacked membrane laid-out on ground, cables are slid in pockets and then corner plates are assembled at the corners. Masts are connected with base plates through pins and then stay cables as well as corner plates are connected with it. The membrane structure is then ready to be erected.

In second steps the membrane structure is erected pivoting the masts at the base one by one with the help of three men. Then stay ropes are then connected with the anchorage plates and masts. Mechanical griphoist will be used to connect and to provide sufficient tension in stay cables.

In step three minor adjustment and rigging are done. For that purpose lightweight scaffolds made of bamboo will be used. Fine tuning of the membrane is achieved through rigging edge cables.



Figure 67: Erection steps for membrane cover

1. Michael Seidel, Tensile surface structures: A practical guide to cable and membrane construction, Ernst & Sohn, 2009

#### **Chapter 06: Conclusion**

In conclusion it can be deduced from previous chapters that one side laminated Jute fabric which is available in the market can be used as membrane cover for visitor shed design, it is the main objective of this study. Jute 13x13 fabric has highest tensile strength. It can withstand wind loads of Dhaka. Though both side laminated Jute fabric is not currently available in market, but it can be ordered from BJRI for large quantities, which is more suitable for Jute as Polypropylene lamination will protect it from humid climate of Dhaka.

The great advantage of this material is that it is cheaper, readily available and environment friendly. But major disadvantage is its durability and relatively weaker strength than conventional fabrics. Further study should be done to make Jute fabric weather proof, durable and higher tensile strength.

Jute fabric may open up as a new potential environment friendly green fabric for tensile membrane structures and it eventually can contribute in economic growth of Bangladesh.

## Bibliography

- 1. The Divan-i Khass in the Palace in the Delhi Fort, http://www.bl.uk/onlinegallery/onlineex/apac/addorimss/t/019addor0004694u00000000.html Accessed on 13-11-12
- 2. Tapobrata Sanyal, "Jute & Jute Geotextiles", http://www.jute.com:8080/c/document\_library/get\_file?uuid=87c9f7ad-ddc6-4b36-9cae-ecf4edd456ec&groupId=22165 Accessed on 14-11-2012
- 3. Prof. Dr. Abdul Jabbar Khan, Major Md Masudur Rahman, "A JGT Reinforced Road Subgrade In Bangladesh", http://www.fibre2fashion.com/industry-article/21/2028/a-jgt-reinforced-road-subgrade-in-bangladesh1.asp accessed on 14-11-12
- 4. Jute products: sacking, http://www.jute.org/jute\_prod\_sac.htm accessed on 16-11-12
- 5. "Local researchers develop jute-made substitute for CI sheet", http://www.thefinancialexpressbd.com/more.php?news\_id=97298&date=2010-04-10 accessed on 14-11-12
- 6. http://tibotaratari.wordpress.com/2010/09/15/taratari-corentin-voiles-et-voiliers-video/ accessed on 14-11-12
- Dr. A. B. Jabbar Khan, "Quality Control of Jute Geotextiles & Development of Testing Facilities", http://www.jute.com:8080/c/document\_library/get\_file?uuid=f1d0dc40-69a9-490c-89c8-ca05dede6918&groupId=22165 accessed on 14-11-12
- 8. History of Dhaka zoo, http://www.dhakazoo.org/history.html accessed on 13-11-12
- 9. http://www.dhaka.climatemps.com/ accessed on 6-12-12
- 10. Brian Forster, Marijke Mollaert; Engineering Fabric Architecture, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 11. Erik Moncrieff, Brian Forster; Glossary, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 12. Jurgen Bradatsch, Peter Patzold, Cristiana Saboia de Freitas, Rudi Scheuermann, Juan Monjo, Marijke Mollaert; Form, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 13. Rabindranath Trivedi, The Durga puja and Minority Rights of Bangladesh, Asian Tribune, 19 October 2012.
- 14. Shireen Akbar, Shamiana: The Mughal Tent, Victoria & Albert Museum, January 1999
- 15. "All set for Biswa Ijtema from Saturday", The Daily Star, 22 December, 2003
- 16. Brian Forster, Marijke Mollaert; Engineering Fabric Architecture, European Design Guide for Tensile Surface Structures, Tensinet, 2004.
- 17. Dr. A.B.M. Abdullah, Jute Geotextiles and Their Applications, Jute Diversification and Promotion Center (JDPC), Dhaka 2008.
- 18. Doan, Thi Thu Loan, Investigation on Jute fibers and their composites based on polypropylene and epoxy matrices, Technischen Universität Dresden, May 2006.
- 19. World Export report of raw Jute, Kenaf and allied fibers from 2003/2004 to 2009/2010, Food and Agriculture Organization (FAO)
- 20. Dr. A. B. Jabbar Khan, Technical Assessment of Jute Geotextiles for Civil Engineering Applications, Department of Civil Engineering, Bangladesh University of Engineering & Technology (BUET), Dhaka, Bangladesh, June 2008
- 21. Mudassir Rashid, "Bangladesh decoded Jute's genome sequencing 'Golden fiber to redeem the lost glory'", Bangladesh Textile Today, Jul-Aug 2010.
- 22. World Export report of raw Jute, Kenaf and allied fibers from 2003/2004 to 2009/2010, Food and Agriculture Organization (FAO)
- 23. Mustafizur Rahman, Nafisa Khaled "Global Market Opportunities In Export of Jute", CPD, 2011, Dhaka
- 24. Capucine Korenberg, "The effect of ultraviolet-filtered light on the mechanical strength of fabrics", The British Museum Technical Research Bulletin, Volum 1 2007.
- 25. Md. Milon Hossain, Rumpa Karmaker, Sudipta Bain, M. A. Jalil and Joykrishna Saha, "Investigation of Influence of Twill Structures on Jute-Cotton Union Fabric Physical Properties", IJASETR, Volume 1, Issue 2, Article #06, April 2012
- 26. Ghosh S. B., Bajaj P., Kothari V. K. "Effect of dyes and finishes on UV protection of jute/cotton fabrics", Indian journal of fibre & textile research, vol. 28, no4, pp. 431-436, 2003
- 27. H. Toyoda, "Recyclable coated fabric using kenaf fiber for architectural membrane structure applications", Fabric Architecture, November 2012, http://fabricarchitecturemag.com/articles/1112\_wp\_kenaf\_fiber.html accessed on 16-11-12.
- 28. Dilara Hossain, BUET finalises clauses for zoo renovation master plan, Bangladesh Sangbad Sangstha (BSS), 6 April 2012.
- 29. Dhaka & Rangpur Zoo Modernization Project, Development Project Proposal (DPP), Ministry of Fisheries and Livestock, July 2010
- 30. W J Lewis, Tension structures: Form and Behavior, Thomas Telford, London, 2003
- 31. Samarendra Karmakar, Md. Mahbub Alam, Development Of Statistical Techniques For The Forecasting Of Nor'westers And Associated Maximum Gusty Wind And Rainfall Over Bangladesh, Journal of Bangladesh Academy of Sciences, Vol. 35, No. 2, 125-140, 2011
- 32. Prof. Dr.-Ing. Lars Schiemann, Dr.-Ing. Karsten Moritz, Structural Design Concepts, IMS, September 2011
- 33. Michael Seidel, Tensile surface structures: A practical guide to cable and membrane construction, Ernst & Sohn, 2009

## List of Figures and Tables

| Figure 01         | Interaction between natural and industrial cycles  | 5        |
|-------------------|--|----------|
| Figure 02         | Structure of the work  | 6        |
| Figure 03         | Fountain tent starwave, colonge, Germany, rebuilt 2000   | 7        |
| Figure 04         | Assembly tent Malaysia,1997, SL Rash   | 7        |
| Figure 05         | Julianus Shopping Mall, Tongeren, Belgium, 2007, The Nomad Concept                                     | 8        |
| Figure 06         | Fort 4 Mortsel, Antwerp, Belgium, 2002, The Nomad Concept  | 8        |
| Figure 07         | Mughal Shamiana in front of Diwan I Khass in the palace of the   |          |
|                   | Delhi Fort, Water color by Ghulam Ali khan   | 9        |
| Figure 08         | Durga puja pandal, author Mukerjee, October 2008   | 9        |
| Figure 09         | A Pandel gateway in Dhaka.   |          |
|                   | (Author Pro. Dr. Shabbir Ahmed, 2011)  | 9        |
| Figure 10         | 10th convocation pandel of Bangladesh University of Engineering & Technology (BUET), 3rd February 2011 | 10       |
| Figure 11         | Bisholjtema on the bank of river Turag, Tongi, Gazipur.( source:                                       |          |
|                   | www.thedailystar.net)  | 10       |
| Figure 12         | Inside view of <i>Bisho ljtema</i> tent. (Author Rocky S. Hossain, 2010)                               | 10       |
| Figure 13         | Jute plant (source http://www.thejutecompany.com/images/juteplant.jpg)                                 | 11       |
| Figure 14         | Jute collection from field (source   |          |
|                   | http://media.lonelyplanet.com/lpi/2994/2994-2//681x454.jpg)  | 11       |
| Figure 15         | Jute fiber extraction (source author Shahnewaz Karim, 2011)  | 11       |
| Figure 16         | Jute fiber is dried in Sun (source right image author Auyon , 2011)                                    | 11       |
| Figure 17         | Hessian Jute rabric  | 13       |
| Figure 18         | Jute Canvas fabric.  | 13       |
| Figure 19         | Jute Double warp (D.w.) twill  | 13       |
| Figure 20         | 50:50 Jute-cotton union fabric   | 13       |
| Figure 21         | One side laminated (13x13) Jule-labric   | 14       |
| Figure 22         | SU:SU Jule-collon biend  | 14       |
| Figure 23         | Une side laminated (ISXIS) Jule-labilic  | 14       |
|                   | 2010)  | 15       |
| Figure 25         | Kenaf plant (source  | 10       |
| Figure 26         | Structure of Kenafine <sup>™</sup> (Source   | 16       |
|                   | http://fabricarchitecturemag.com/articles/1112_np9_material_research.html)                             | 17       |
| Figure 27         | Dhaka zoo satellite image. Source: Google earth  | 18       |
| Figure 28         | Existing visitor's shed in Dhaka zoo.  | 18       |
| Figure 29         | Site location for a prototype visitor's shed.  | 19       |
| Figure 30         | Some sketches of design development phases   | 20       |
| Figure 31         | Perspective view   | 20       |
| Figure 32         | Plan<br>South Elementaria  | 21       |
| Figure 33         | South Elevation  | 21       |
| Figure 34         | West Elevation   | 21       |
| Figure 35         | Physical model scale 1:50  | 22       |
| Figure 36         | S-11 stresses after formfinding  | 23       |
| Figure 37         | Signa 22 stresses after forminiting  | 24       |
| Figure 38         | Juxiaposed shadows from 8am to 4pm   | 24       |
| Figure 39         | Cp Zone definitions for wind X direction   | 23       |
| Figure 40         | S-11 stress in loadcase LILS-3   | 20<br>27 |
| Figure 41         | Displacement in loadcase SLS02   | 27       |
| Figure 12         | Displacement in loadcase \$1502  | 20<br>20 |
| Figure 43         | Ton view of the pattern  | 20<br>20 |
| Figure 15         | Fast View  | 29<br>20 |
| Figure 16         | South view   | 29       |
| Figure 17         | Final natterns   | 30       |
| Figure 48         | Section AA   | 30       |
| Figure <u>4</u> 9 | Section BB   | 31       |
| Figure 50         | Section CC   | 31       |

| Figure 51 | Single pattern                                   | 32 |
|-----------|--|----|
| Figure 52 | Nesting of the patterns on the Jute 13x13 fabric | 32 |
| Figure 53 | Edge cables                                      | 32 |
| Figure 54 | Stay cables and safety cables                    | 33 |
| Figure 55 | Location of the corner plates                    | 34 |
| Figure 56 | Corner Plate CP01 detail                         | 34 |
| Figure 57 | Corner Plate CP02 detail                         | 35 |
| Figure 58 | Corner Plate CP03 detail                         | 35 |
| Figure 59 | Connection with Mast01                           | 36 |
| Figure 60 | Connection with Mast02                           | 37 |
| Figure 61 | Mast01   | 38 |
| Figure 62 | Mast02   | 38 |
| Figure 63 | Foundation layout                                | 39 |
| Figure 64 | Mast01 footing                                   | 39 |
| Figure 65 | Mast02 footing                                   | 39 |
|           |  |    |

44

| Figure 66 | Time schedule                     |
|-----------|-----------------------------------|
| Figure 67 | Erection steps for membrane cover |



#### Appendices

#### Appendix 01: Tensile Strength Lab Test Results

|  | DEPARTMEN<br>Mobile: 01819 5:  | T OF CIVIL E<br>57964; PABX: 966 56   | NGINEERING<br>50-80 Ext. 7226   | 377   |   |
|--|--|---|---|---|---|
|  | GEOTECHNICA  | L ENGINEERING   | G LABORATORY  | Testing & Const   | ultation  |
|  | TESTING OF   | LAMINATED JUT   | ETEXTILE  |   | Page: 1/  |
| BRTC No:<br>Sent by:   | 110035364/ CE/ 12-13<br>Mr. Golam Mursalin Chowdhury<br>85/A R K. Mission Road, Dhaka-1203   | Date: 06/11/1   | 2 Specimen ID:<br>Colour:   | BRTC35364(L0<br>Brown   | G)  |
| Reference:<br>Proiect:   | Letter   | Date: 06/11/1   | 2   |   |   |
| Date of Test:  | 07/11/12   | est Method: ASTM/ E   | DIN   |   |   |
|  | TE   | EST RESULTS   |   |   |   |
|  | Test Parameter   | Direction   | Test Standard   | Unit  | Test<br>Result  |
| Average Ma   | ss per unit Area   | -   | ASTM D5261  | gm/m <sup>2</sup>   | 376   |
| Average Thi  | ckness (under a Pressure of 2 kPa)   |   | ASTM D5199  | mm  |   |
| Apparent/ Ef   | fective Opening Size   |   | ASTM D4751 <sup>+</sup>   | micron  |   |
| Average Horizontal Permeability at 20 °C   |  |   | ASTM D4716/DIN  | x10 <sup>-3</sup> m/sec   |   |
| Average Ho   | rizontal Permeability at 20 °C   | 0.000   | ALL DESCRIPTION OF ALL DAMA ALL DESCRIPTIONS OF                           |   |   |
| Average Hoi<br>Average Ver   | tical Permeability at 20 °C  | -   | DIN   | x10 <sup>-3</sup> m/sec   |   |
| Average Hor<br>Average Ver<br>Average Pe   | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C  |   | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec   |   |
| Average Hoi<br>Average Ver<br>Average Pe   | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C  | <br><br>MD/ Direction X*  | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N  |   |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra  | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)   | MD/ Direction X*  | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N  |   |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra  | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)   | MD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup><br>MD/ Direction X <sup>4</sup>   | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%  |   |
| Average Hoi<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra   | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)  | MD/ Direction X*<br>XMD/ Direction X*<br>MD/ Direction X*<br>XMD/ Direction X*  | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%  |   |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra   | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>rip Tensile Strength at 20 °C (RT)  | MD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup>  | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m                             | <br><br><br><br>15.4  |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra   | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>rip Tensile Strength at 20 °C (RT)  | MD/ Direction X*<br>XMD/ Direction X*<br>XMD/ Direction X*<br>XMD/ Direction X*<br>XMD/ Direction X*<br>XMD/ Direction X*   | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m<br>kN/m                     | <br><br><br><br>15.4<br>16.7                                |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra<br>Average Stri<br>Average Stri                 | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>rip Tensile Strength at 20 °C (RT)<br>p Tensile Elongation at 20 °C (RT)  | MD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup>   | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m<br>kN/m<br>%                | <br><br><br>15.4<br>16.7<br>10                              |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra<br>Average Stri                                 | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>ip Tensile Strength at 20 °C (RT)<br>p Tensile Elongation at 20 °C (RT)   | MD/ Direction X <sup>4</sup><br>XMD/ Direction X <sup>4</sup>           | DIN<br>ASTM D4491   | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m<br>kN/m<br>%                | <br><br><br>15.4<br>16.7<br>10<br>10                        |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra<br>Average Str<br>Average Str<br>Average Str    | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>rip Tensile Strength at 20 °C (RT)<br>p Tensile Elongation at 20 °C (RT)<br>uncture Resistance °C (RT)                            | MD/ Direction X*<br>XMD/ Direction X*<br>XMD/ Direction X<br>MD/ Direction X<br>XMD/ Direction X<br>MD/ Direction X<br>XMD/ Direction X*<br>XMD/ Direction X*   | DIN<br>ASTM D4491<br>ASTM D4632<br>ASTM D4632                             | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m<br>kN/m<br>%<br>%<br>N      | <br><br><br>15.4<br>16.7<br>10<br>10<br>                    |
| Average Hor<br>Average Ver<br>Average Pe<br>Average Gra<br>Average Gra<br>Average Stri<br>Average Stri<br>Average Stri | rizontal Permeability at 20 °C<br>tical Permeability at 20 °C<br>rmitivity at 20 °C<br>ab Tensile Strength °C (RT)<br>ab Tensile Elongation °C (RT)<br>ip Tensile Elongation at 20 °C (RT)<br>p Tensile Elongation at 20 °C (RT)<br>uncture Resistance °C (RT)<br>e of Bag at 20 °C (RT) | MD/ Direction X <sup>4</sup><br>XMD/ Direction Y<br>MD/ Direction Y<br> | DIN<br>ASTM D4491<br>ASTM D4632<br>ASTM D4632<br>ASTM D4595<br>ASTM D4595 | x10 <sup>-3</sup> m/sec<br>x 10 <sup>-2</sup> / sec<br>N<br>N<br>%<br>%<br>kN/m<br>kN/m<br>%<br>%<br>N<br>N | <br><br><br>15.4<br>16.7<br>10<br>10<br>10<br><br>1150 x 79 |

+ Sand fractions were used in place of glass beads. RT = Room Temperature

\* Machine Direction (MD) and Cross Machine Dirrection (XMD) were not identifiable. Instead, arbitrarily X and Y directions were chosen **Samples were received in unsealed condition** 

Countersigned by:

w

Dr. Md. Abdur Rouf Professor, Civil Engg. Dept.



Test Performed by: 14.11.12 Dr. Md. Zoynul Abedin

Professor, Civil Engg. Dept.

Important Notes:

Samples as supplied to us have been tested in our laboratory. As such, BRTC does not have any responsibility as to the representativeness the samples required to be tested. It is recommended that samples are sent in a secured cover/ packet/ container duly sealed and signed by competent authority. In order to avoid fradulent fabrication of test results, it is recommended that the test reports be collected by an authority person, and not by the contractor/ Supplier.

# BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)



Colour : Brown

Sample seal condition : Unsealed

## TEST RESULTS ON LAMINATED JUTE FABRIC

| Parameter                                     | Test Standard | Unit              | Test Result |
|---|---------------|-------------------|-------------|
| Mass per Unit Area                            | ASTM D3776    | gm/m <sup>2</sup> | 331         |
| Wide Width (Strip) Tensile Strength at 20°C   | ASTM D4595    | kN/m              | 14/12       |
| Wide Width (Strip) Tensile Elongation at 20°C | ASTM D4595    | %                 | 12/8        |

Note: Where two values are provided, they refer to two perpendicular directions



3

Countersigned by:

Test performed by: 11/12/12

Dr. Abu Siddique Professor Department of Civil Engineering Bangladesh University of Engineering and Technology, Dhaka, Bangladigh

#### BANGLADESH UNIVERSITY OF ENGINEERING AND TECHNOLOGY (BUET)



DEPARTMENT OF CIVIL ENGINEERING Mobile: 01819 557964; PABX: 966 5650-80 Ext. 7226

**G**EOTECHNICAL ENGINEERING LABORATORY

Date: 06/11/12

Date: 06/11/12



Specimen ID: BRTC35364(LG)

Colour: Brown

#### TESTING OF JUTE COTTON BLEND TEXTILE

Page: 2/2

110035364/ CE/ 12-13 BRTC No: Mr. Golam Mursalin Chowdhury Sent by: 85/A R.K. Mission Road, Dhaka-1203 Reference: Letter

Project: Date of Test: 07/11/12

Test Method: ASTM/ DIN

#### **TEST RESULTS**

| Test Parameter                                 | Direction         | Test Standard           | Unit                     | Test<br>Result |
|--|-------------------|-------------------------|--------------------------|----------------|
| Average Mass per unit Area                     |                   | ASTM D5261              | gm/m <sup>2</sup>        | 2213           |
| Average Thickness (under a Pressure of 2 kPa)  | -                 | ASTM D5199              | mm                       |                |
| Apparent/ Effective Opening Size               |                   | ASTM D4751 <sup>+</sup> | micron                   |                |
| Average Horizontal Permeability at 20 °C       |                   | ASTM D4716/DIN          | x10 <sup>-3</sup> m/sec  |                |
| Average Vertical Permeability at 20 °C         |                   | DIN                     | x10 <sup>-3</sup> m/sec  |                |
| Average Permitivity at 20 °C                   |                   | ASTM D4491              | x 10 <sup>-2</sup> / sec | I              |
| Average Crab Tensile Strength                  | MD/ Direction X*  | ASTM D4632              | N                        |                |
| Average Grab Tensile Strength C (RT)           | XMD/ Direction Y* |                         | N                        |                |
| Average Creb Tappile Elegantian                | MD/ Direction X*  | ASTIVI D4032            | %                        |                |
| Average Grab Tensile Elongation C (RT)         | XMD/ Direction Y* |                         | %                        |                |
| Average Strip Topsile Strongth at 20 °C (DT)   | MD/ Direction X*  |                         | kN/m                     | 18.1           |
| Average Surp rensile Strength at 20 C (RT)     | XMD/ Direction Y* |                         | kN/m                     | 15.2           |
| Automa Chin Tanaila Elegation at 20, 80 (BT)   | MD/ Direction X*  | ASTM D4595              | %                        | 4              |
| Average Strip Tensile Elongation at 20 °C (RT) | XMD/ Direction Y* | (M)                     | %                        | 22             |
| Avg. CBR Puncture Resistance °C (RT)           | 5. <del></del>    | ASTM D6241              | N                        |                |
| Average Size of Bag at 20 °C (RT)              |                   |                         |                          | 1150 x 798     |
| Average Seam Strength at 20 °C (RT)            | · · · ·           | ASTM D4884              | N                        | ·              |

+ Sand fractions were used in place of glass beads. RT = Room Temperature

\* Machine Direction (MD) and Cross Machine Dirrection (XMD) were not identifiable. Instead, arbitrarily X and Y directions were chosen Samples were received in unsealed condition

Countersigned by

Dr. Md. Abdur Rouf Professor, Civil Engg. Dept.



Test Performed by: - H-11-12 (2)

Dr. Md. Zoynul Abedin Professor, Civil Engg. Dept.

Important Notes:

---

Samples as supplied to us have been tested in our laboratory. As such, BRTC does not have any responsibility as to the representativenes the samples required to be tested. It is recommended that samples are sent in a secured cover/ packet/ container duly sealed and signed is competent authority. In order to avoid fradulent fabrication of test results, it is recommended that the test reports be collected by an authority.

person, and not by the contractor/ Supplier.

#### Appendix 02: Cost Estimation

#### Target price calculation for

#### 1. MEMBRANE

| Cost Membrane PVC MEM  | IBRANE | total€ | 510   |      |                  |
|------------------------|--------|--------|-------|------|------------------|
|                        |        | 00.00  | .200  | 0.00 |                  |
| confection price       | m²     | 85.00  | 425€  | 5.00 | Conf €/m²        |
| Sales Price Material   |        |        | 85€   | 1.00 | Mat<br>Preis€/m2 |
| total consumption      | m²     |        | 85.00 |      |                  |
| additional consumption | m²     |        | 25    |      |                  |
|                        | m²     |        | 60.00 |      |                  |
| wastage factor         |        | FACTOR | 1.60  |      |                  |
| Surface (SUR)          | m²     | 25.00  | 37.50 |      |                  |
| surface factor         |        | FACTOR | 1.50  |      |                  |
| covered floor are      | m²     | 25.00  |       |      |                  |
|                        |        |        | check |      |                  |
| Type Jute 13x13        |        |        |       |      |                  |

#### 2. STEEL

| 2.1 | Fittings/ small parts | pieces |   | € total | kg total | kg/piece | €/kg |
|-----|-----------------------|--------|---|---------|----------|----------|------|
|     | membrane corners      | 6      |   | 54.00   | 9.00     | 1.50     | 6.00 |
|     | SUBTOTAL FITTINGS     |        | € | 54.00   |          |          |      |
|     |                       |        |   |         |          |          |      |

| 2.2 | MASTS (High Point) galvanised | pieces | length/piece | € total | kg tota |
|-----|-------------------------------|--------|--------------|---------|---------|
|     | diameter 89 mm                | 2      | 6.00         | 300.00  | 60.00   |
|     | diameter 60 mm                | 2      | 3.50         | 175.00  | 35.00   |
|     | SUBTOTAL MASTS (High Point)   |        | €            | 475.00  |         |

| total | kg/m | €/kg |
|-------|------|------|
| 0.00  | 5.00 | 5.00 |
| 5.00  | 5.00 | 5.00 |

| 2.3 | STEEL FITTINGS                  | pieces |  | € total | kg total |  |
|-----|---------------------------------|--------|--|---------|----------|--|
|     | for masts-footing-cable plates  | 14     |  | 168.36  | 28.00    |  |
|     | SUBTOTAL GENERAL STEEL FITTINGS |        |  | 168.36  |          |  |

| kg/piece | €/kg |
|----------|------|
| 2.00     | 6.01 |

TOTAL STEEL

TOTAL € 697

#### 3. CABLES

| 3.1 | MEMBRANE EDGE CABLES          | Piece  | length/piece | € total | m     | €/m     |
|-----|-------------------------------|--------|--------------|---------|-------|---------|
|     | diameter 6.1mm                | 2      | 5.60         | 56.00   | 11.20 | 5.00    |
|     |                               | 4      | 4.20         | 84.00   | 16.80 | 5.00    |
|     |                               | Piece  | x2           | € total | Piece | €/Piece |
|     | thread fitting for 6.1 mm     | 6      | 12.00        | 240     | 12.00 | 20      |
|     | SUBTOTAL MEMBRANE EDGE CABLES |        | €            | 380     |       |         |
|     |                               |        |              |         | -     |         |
| 3.2 | STAY CABLES                   | pieces | m/piece      | € total | m     | €/m     |

|     |                 | pieces | x2      | € total | piece | €/piece |
|-----|-----------------|--------|---------|---------|-------|---------|
|     |                 |        | 2.00    | 20.00   | 4.00  | 5.00    |
|     |                 | 4      | 4.00    | 80.00   | 16.00 | 5.00    |
|     | diameter 6.1 mm | 4      | 7.40    | 148.00  | 29.60 | 5.00    |
| 3.2 | STAY CABLES     | pieces | m/piece | € total | m     | €/m     |

| 3.3 | LINK CABLES               | pieces | m/piece | €total  | m     | €/m     |
|-----|---------------------------|--------|---------|---------|-------|---------|
|     | diameter 6.1 mm           | 2      | 1.00    | 10.00   | 2.00  | 5.00    |
|     | diameter 8.1 mm           | 2      | 0.55    | 5.50    | 1.10  | 5.00    |
|     |                           | pieces | x2      | € total | Piece | €/Piece |
|     | thread fitting for 6.1 mm | 2      | 4.00    | 80      | 4.00  | 20      |
|     | thread fitting for 8.1mm  | 2      | 4.00    | 100     | 4.00  | 25      |
|     | SUBTOTAL LINK CABLES      |        | (       | € 110   |       |         |

| 3.4 | SAFETY CABLES             | pieces | m/piece | €total  | m     | €/m     |
|-----|---------------------------|--------|---------|---------|-------|---------|
|     | diameter 6.1 mm           | 2      | 8.50    | 85.00   | 17.00 | 5.00    |
|     |                           | 2      | 7.50    | 75.00   | 15.00 | 5.00    |
|     |                           | pieces | x2      | € total | Piece | €/Piece |
| _   | thread fitting for 6.1 mm | 4      | 8.00    | 160     | 8.00  | 20      |
|     | SUBTOTALSAFETY CABLES     |        | €       | 245     |       |         |

| TOTAL CABLES total € 1,383 |
|----------------------------|
|----------------------------|

|  | WHOLE 1-3 SUBTOTAL | € | 2,590 |
|--|--------------------|---|-------|
|--|--------------------|---|-------|

| 4   | TRANSPORT          |                |     |
|-----|--------------------|----------------|-----|
| 1   |                    | ka             |     |
| . I | WEIGHT             | ky<br>€/kg     |     |
| 2   | VOLUME             | m <sup>3</sup> |     |
|     |                    | €/m³           |     |
| 3   | PACKING            | €              |     |
|     | SUBTOTAL TRANSPORT | € lump sum     | 300 |
|     |                    |                |     |
| 5   | ERECTION           |                |     |
| -   | Working            | man-           |     |

| 5.1 | man-days     | days   | Mann | days     | €/day   |        |
|-----|--------------|--------|------|----------|---------|--------|
|     | 1worker/1day | 3      | 3    | 9.00     | 20.00   |        |
|     |              |        |      | _        | € total | 180.00 |
| 5.2 | TRAVEL       |        | 3    | €/travel | 5.00    |        |
|     |              |        |      |          | € total | 15.00  |
| 5.3 | Scaffolding  |        |      | € total  | on site | 200.00 |
|     | SUBTOTAL ER  | ECTION |      | €        |         | 395.00 |

| 6 | FOUNDATION       |   |    |            |      |          |
|---|------------------|---|----|------------|------|----------|
|   |                  |   |    | Unit price |      |          |
|   | Amount           | 7 | m³ | 400.00     | €/m³ | 2,800.00 |
|   | FOUNDATION TOTAL |   |    |            |      | 2,800.00 |

#### 7 Planning cost Engineering

|                      | of building      |   |        |
|----------------------|------------------|---|--------|
| about 30%            | cost             |   |        |
| SUBTOTAL PLANNING CO | OST ENGINEERING  | € | 985.61 |
| TOTAL, INCLUDED PLAN | NING WITHOUT VAT | € | 7,071  |

| 8   | Approval membrane                    |            |           |         |        |
|-----|--------------------------------------|------------|-----------|---------|--------|
| 8.1 | fees government structural verificat | ion        |           | _       | Client |
| 8.2 | fees government structural verificat | ion in siı | ngle case |         | Client |
| 8.3 | testing membrane                     |            |           |         |        |
|     |                                      |            |           | € total | 1000   |
| 9.  | ON SITE TASKS                        |            |           |         |        |
|     | SURVEYING                            | €          | 500.00    |         |        |
| 10  | General Contractor addition          |            | 0.10      | 857.1   |        |
| Gra | and Total                            |            | €         | 9428    |        |















| 0.0847                            |  |  |  |
|-----------------------------------|--|--|--|
| membrane sigma 22 stresses (KN/m) |  |  |  |
|                                   |  |  |  |





| membrane sig | ma 22 stres | ses (KN/m | ð |  | $\frown$ |   | с – – н |  |  |
|--------------|-------------|-----------|---|--|----------|---|---------|--|--|
|              |             |           |   |  | <br>7    | 1 |         |  |  |





| membrane | sigma 22 stre | sses (KN/m | ) | e | $\frown$ | 1 | c |  |  |
|----------|---------------|------------|---|---|----------|---|---|--|--|
|          |               |            |   |   |          | 1 |   |  |  |





| 0.1520  |  |  |
|---|--|--|
| 0.0000  |  |  |
|   |  |  |
| a second s |  |  |
| membrane sigma 22 stresses (KN/m)   |  |  |
|   |  |  |
|   |  |  |





### ULS 03

| 0.3241                            | $\sim$ |              | / |  | - |  | $\sum$ |
|-----------------------------------|--------|--------------|---|--|---|--|--------|
| 0.0000                            | $\sim$ | $\mathbf{x}$ |   |  |   |  |        |
| membrane sigma 22 stresses (KN/m) |        | $\nearrow$   |   |  |   |  |        |
|                                   | 7      |              |   |  |   |  |        |

Appendix 04: Forten Analysis Report



Figure 68: Mast Position

## Mast M01 Report

| work | SLS01:element            | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|------|--------------------------|-------------------------|----|------|------|------|
| WORK | N                        | V2                      | V3 | т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -5.362                   | 0                       | 0  | 0    | 0    | 0    |
| 407  | -5.362                   | 0                       | 0  | 0    | 0    | 0    |
| work | SLS02:element<br>results | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -17.345                  | 0                       | 0  | 0    | 0    | 0    |
| 407  | -17.345                  | 0                       | 0  | 0    | 0    | 0    |
| work | SLS03:element<br>results | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -17.657                  | 0                       | 0  | 0    | 0    | 0    |
| 407  | -17.657                  | 0                       | 0  | 0    | 0    | 0    |
| work | ULS01:element<br>results | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -5.479                   | 0                       | 0  | 0    | 0    | 0    |
| 407  | -5.479                   | 0                       | 0  | 0    | 0    | 0    |
| work | ULS02:element<br>results | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -22.74                   | 0                       | 0  | 0    | 0    | 0    |
| 407  | -22.74                   | 0                       | 0  | 0    | 0    | 0    |
| work | ULS03:element<br>results | Wed<br>Jan<br>9<br>2013 |    |      |      |      |
|      | Ν                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 407  | -23.05                   | 0                       | 0  | 0    | 0    | 0    |
| 407  | -23.05                   | 0                       | 0  | 0    | 0    | 0    |

# Mast M02 Report

| work   | SLS01:element results   | Wed<br>Jan 9<br>2013   |  |   |  |  |
|--|---|--|--|---|--|--|
|  | N   | V2   | V3   | Т   | M2   | M3   |
| N°   | KN  | KN   | KN   | KN m  | KN m   | KN m   |
| 405  | -3.664  | 0  | 0  | 0   | 0  | 0  |
| 405  | -3.664  | 0  | 0  | 0   | 0  | 0  |
| work   | SLS02:element<br>results  | Wed<br>Jan 9<br>2013   |  |   |  |  |
|  | N   | V2   | V3   | Т   | M2   | M3   |
| N°   | KN  | KN   | KN   | KN m  | KN m   | KN m   |
| 405  | -12.068   | 0  | 0  | 0   | 0  | 0  |
| 405  | -12.068   | 0  | 0  | 0   | 0  | 0  |
| work   | SLS03:element<br>results  | Wed<br>Jan 9<br>2013   |  |   |  |  |
|  | N   | V2   | V3   | Т   | M2   | M3   |
| N°   | KN  | KN   | KN   | KN m  | KN m   | KN m   |
| 405  | -12.552   | 0  | 0  | 0   | 0  | 0  |
| 405  | -12.552   | 0  | 0  | 0   | 0  | 0  |
| work   | ULS01:element<br>results  | Wed<br>Jan 9<br>2013   |  |   |  |  |
|  | Ν   | \/2  | \/3  | -   | M2   | M2   |
| N°   |   | V Z  | ٧J   |   | 1112   | IVIS   |
|  | KN  | KN   | KN   | ı<br>KN m   | KN m   | KN m   |
| 405  | KN<br>-3.72   | KN<br>0  | KN<br>0  | KN m<br>0   | KN m<br>0  | KN m   |
| 405<br>405   | KN<br>-3.72<br>-3.72  | KN<br>0<br>0   | KN<br>0<br>0   | KN m<br>0<br>0                                    | KN m<br>0<br>0   | KN m<br>0<br>0   |
| 405<br>405<br>work   | KN<br>-3.72<br>-3.72<br>ULS02:element<br>results  | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013   | KN<br>0<br>0   | KN m<br>0<br>0                                    | KN m<br>0  | KN m<br>0<br>0   |
| 405<br>405<br>work   | KN<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N   | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2   | KN<br>0<br>0<br>V3   | T   | KN m<br>0<br>0   | M3<br>KN m<br>0<br>0   |
| 405<br>405<br>work   | KN<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N<br>KN   | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN   | V3<br>KN   | KN m<br>0<br>0<br>T<br>KN m                       | KN m<br>0<br>0<br>0<br>KN m  | M3<br>KN m<br>0<br>0<br>KN m                                 |
| 405<br>405<br>work<br>N°<br>405                                    | KN<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N<br>KN<br>-15.819  | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0  | KN<br>0<br>0<br>0<br>V3<br>KN<br>0                                 | KN m<br>0<br>0<br>0<br>V<br>KN m<br>0             | KN m<br>0<br>0<br>0<br>0<br>KN m                                       | M3<br>KN m<br>0<br>0<br>0<br>KN m<br>0                       |
| 405<br>405<br>work<br>N°<br>405<br>405                             | KN<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N<br>KN<br>-N<br>-15.819  | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0<br>0   | KN<br>0<br>0<br>0<br>0<br>V3<br>KN<br>0<br>0                       | KN m<br>0<br>0<br>0<br>0<br>0<br>0                | M2<br>KN m<br>0<br>0<br>0<br>0<br>0                                    | M3<br>KN m<br>0<br>0<br>0<br>0<br>KN m<br>0<br>0             |
| 405<br>405<br>work<br>N°<br>405<br>405<br>work                     | KN         -3.72         -3.72         ULS02:element results         N         KN         -15.819         -15.819         ULS03:element results | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0<br>0<br>0<br>0<br>Wed<br>Jan 9<br>2013                         | KN<br>0<br>0<br>0<br>0<br>KN<br>0<br>0                             | KN m<br>0<br>0<br>0                               | M2<br>KN m<br>0<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0                               |
| 405<br>405<br>work<br>N°<br>405<br>405<br>work                     | KN<br>-3.72<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N<br>KN<br>-15.819<br>-15.819<br>ULS03:element<br>results                          | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2                        | KN<br>0<br>0<br>0<br>0<br>V3<br>KN<br>0<br>0<br>0<br>0             | KN m<br>0<br>0<br>0<br>0                          | M2<br>KN m<br>0<br>0<br>0<br>0<br>KN m<br>0<br>0<br>0                  | M3<br>KN m<br>0<br>0<br>0<br>0<br>KN m<br>0<br>0<br>0        |
| 405<br>405<br>work<br>N°<br>405<br>405<br>work                     | KN<br>-3.72<br>-3.72<br>-3.72<br>ULS02:element<br>results<br>N<br>-15.819<br>-15.819<br>ULS03:element<br>results<br>N<br>KN                     | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN                  | KN<br>0<br>0<br>0<br>0<br>V3<br>KN<br>0<br>0<br>0<br>0             | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0      | M2<br>KN m<br>0<br>0<br>0<br>0<br>KN m<br>0<br>0<br>0                  | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0           |
| 405<br>405<br>work<br><u>N°</u><br>405<br>405<br>work<br><u>N°</u> | KN<br>3.72<br>3.72<br>ULS02:element<br>results<br>N<br>KN<br>15.819<br>15.819<br>ULS03:element<br>results<br>N<br>KN<br>KN                      | KN<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>0<br>0<br>0<br>0<br>Wed<br>Jan 9<br>2013<br>V2<br>KN<br>V2<br>KN | KN<br>0<br>0<br>0<br>V3<br>KN<br>0<br>0<br>0<br>0<br>V3<br>KN<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |

Stay Cable Type A Report

| work                     | SLS01:element<br>results                                    | Mon<br>Jan<br>7<br>2013                             |                                |                             |                                   |                                |
|--------------------------|---|---|--------------------------------|-----------------------------|-----------------------------------|--------------------------------|
|                          | N   | V2  | V3                             | Т                           | M2                                | M3                             |
| N°                       | KN  | KN  | KN                             | KN m                        | KN m                              | KN m                           |
| 415                      | 1.994   | 0   | 0                              | 0                           | 0                                 | 0                              |
| 416                      | 1.708   | 0   | 0                              | 0                           | 0                                 | 0                              |
| work                     | SLS02:element<br>results                                    | Mon<br>Jan<br>7<br>2013                             |                                |                             |                                   |                                |
|                          | N   | \/2   | 1/2                            | Ŧ                           | 140                               |                                |
|                          |   | ٧Z  | ٧J                             |                             | IVIZ                              | M3                             |
| N°                       | KN  | KN  | v 3<br>KN                      | ı<br>KN m                   | ™∠<br>KN m                        | M3<br>KN m                     |
| <mark>N°</mark><br>415   | KN<br>4.878   | KN<br>0   | v3<br>KN<br>0                  | KN m<br>0                   | KN m                              | M3<br>KN m<br>0                |
| N°<br>415<br>416         | KN<br>4.878<br>7.157  | V2<br>KN<br>0<br>0                                  | V3<br>KN<br>0<br>0             | KN m<br>0<br>0              | M2<br>KN m<br>0<br>0              | M3<br>KN m<br>0<br>0           |
| N°<br>415<br>416<br>work | KN<br>4.878<br>7.157<br>SLS03:element<br>results            | KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013             | V3<br>KN<br>0                  | KN m<br>0<br>0              | M2<br>KN m<br>0                   | M3<br>KN m<br>0<br>0           |
| N°<br>415<br>416<br>work | KN<br>4.878<br>7.157<br>SLS03:element<br>results<br>N       | KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013<br>V2       | V3<br>KN<br>0<br>0             | KN m<br>0<br>0              | M2<br>KN m<br>0<br>0              | M3<br>KN m<br>0<br>0           |
| N°<br>415<br>416<br>work | KN<br>4.878<br>7.157<br>SLS03:element<br>results<br>N<br>KN | KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013<br>V2<br>KN | V3<br>KN<br>0<br>0<br>V3<br>KN | KN m<br>0<br>0<br>0<br>KN m | M2<br>KN m<br>0<br>0<br>0<br>KN m | M3<br>KN m<br>0<br>0<br>V<br>0 |

| 416                                   | 7.335  | 0  | 0  | 0                        | 0                              | 0   |
|---------------------------------------|--|--|--|--------------------------|--------------------------------|---|
| work                                  | ULS01:element<br>results   | Mon<br>Jan<br>7<br>2013  |  |                          |                                |   |
|                                       | N  | V2   | V3                                       | т                        | M2                             | M3  |
| N°                                    | KN   | KN   | KN                                       | KN m                     | KN m                           | KN m  |
| 415                                   | 1.982  | 0  | 0  | 0                        | 0                              | 0   |
| 416                                   | 1.698  | 0  | 0  | 0                        | 0                              | 0   |
| work                                  | ULS02:element  | Mon<br>Jan<br>7<br>2013  |  |                          |                                |   |
| WORK                                  | results  | 2010   |  |                          |                                |   |
| work                                  | N  | V2   | V3                                       | Т                        | M2                             | M3  |
| N°                                    | N<br>KN  | V2<br>KN   | V3<br>KN                                 | T<br>KN m                | M2<br>KN m                     | M3<br>KN m  |
| N°<br>415                             | N<br>KN<br>6.06  | V2<br>KN<br>0  | V3<br>KN<br>0                            | T<br>KN m<br>0           | M2<br>KN m<br>0                | M3<br>KN m<br>0                                       |
| N°<br>415<br>416                      | N<br>KN<br>6.06<br>9.556   | V2<br>KN<br>0  | V3<br>KN<br>0<br>0                       | T<br>KN m<br>0           | M2<br>KN m<br>0                | M3<br>KN m<br>0<br>0                                  |
| N°<br>415<br>416<br>work              | N<br>KN<br>6.06<br>9.556<br>ULS03:element<br>results                     | V2<br>KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013                  | V3<br>KN<br>0<br>0                       | T<br>KN m<br>0<br>0      | M2<br>KN m<br>0<br>0           | M3<br>KN m<br>0<br>0                                  |
| N°<br>415<br>416<br>work              | N<br>KN<br>6.06<br>9.556<br>ULS03:element<br>results<br>N                | V2<br>KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013<br>V2            | V3<br>KN<br>0<br>0                       | T<br>KN m<br>0<br>0      | M2<br>KN m<br>0<br>0           | M3<br>KN m<br>0<br>0                                  |
| N°<br>415<br>416<br>work              | N<br>KN<br>6.06<br>9.556<br>ULS03:element<br>results<br>N<br>KN          | V2<br>KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013<br>V2<br>KN      | V3<br>KN<br>0<br>0<br>V3<br>KN           | T<br>KN m<br>0<br>0      | M2<br>KN m<br>0<br>0           | M3<br>KN m<br>0<br>0<br>0<br>0                        |
| N°<br>415<br>416<br>work<br>N°<br>415 | N<br>KN<br>6.06<br>9.556<br>ULS03:element<br>results<br>N<br>KN<br>5.649 | V2<br>KN<br>0<br>0<br>Mon<br>Jan<br>7<br>2013<br>V2<br>KN<br>0 | V3<br>KN<br>0<br>0<br>0<br>V3<br>KN<br>0 | T<br>KN m<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>8<br>8<br>KN m<br>0 |

# Stay Cable Type C Report

| work | SLS01:element<br>results | Jan<br>8<br>2013        |    |      |      |      |
|------|--------------------------|-------------------------|----|------|------|------|
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 410  | 2.025                    | 0                       | 0  | 0    | 0    | 0    |
| 409  | 1.794                    | 0                       | 0  | 0    | 0    | 0    |
| work | SLS02:element<br>results | Tue<br>Jan<br>8<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 410  | 5.446                    | 0                       | 0  | 0    | 0    | 0    |
| 409  | 7.619                    | 0                       | 0  | 0    | 0    | 0    |
| work | SLS03:element<br>results | Tue<br>Jan<br>8<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 410  | 6.048                    | 0                       | 0  | 0    | 0    | 0    |
| 409  | 7.718                    | 0                       | 0  | 0    | 0    | 0    |
| work | ULS01:element<br>results | Tue<br>Jan<br>8<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 410  | 2.009                    | 0                       | 0  | 0    | 0    | 0    |
| 409  | 1.784                    | 0                       | 0  | 0    | 0    | 0    |
| work | ULS02:element<br>results | Tue<br>Jan<br>8<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 410  | 6.891                    | 0                       | 0  | 0    | 0    | 0    |
| 409  | 10.138                   | 0                       | 0  | 0    | 0    | 0    |
| work | ULS03:element<br>results | Tue<br>Jan<br>8<br>2013 |    |      |      |      |
|      | Ν                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |

| 410 | 7.749  | 0 | 0 | 0 | 0 | 0 |
|-----|--------|---|---|---|---|---|
| 409 | 10.235 | 0 | 0 | 0 | 0 | 0 |

# Stay Cable Type E Report

| work | SLS01:element            | Tue<br>Jan<br>8<br>2013  |          |           |            |            |
|------|--------------------------|--------------------------|----------|-----------|------------|------------|
|      | N                        | V2                       | V3       | т         | M2         | M3         |
| N°   | KN                       | KN                       | KN       | KN m      | KN m       | KN m       |
| 417  | 2.671                    | 0                        | 0        | 0         | 0          | 0          |
| work | SLS02:element<br>results | Tue<br>Jan<br>8<br>2013  |          |           |            |            |
| N°   | N<br>KN                  | V2<br>KN                 | V3<br>KN | T<br>KN m | M2<br>KN m | M3<br>KN m |
| 417  | 4.319                    | 0                        | 0        | 0         | 0          | 0          |
| work | SLS03:element<br>results | Tue<br>Jan<br>8<br>2013  |          |           |            |            |
| N°   | N<br>KN                  | V2<br>KN                 | V3<br>KN | T<br>KN m | M2<br>KN m | M3<br>KN m |
| 417  | 4.593                    | 0                        | 0        | 0         | 0          | 0          |
| work | ULS01:element<br>results | l ue<br>Jan<br>8<br>2013 |          |           |            |            |
| N°   | N<br>KN                  | V2<br>KN                 | V3<br>KN | T<br>KN m | M2<br>KN m | M3<br>KN m |
| 417  | 2.663                    | 0                        | 0        | 0         | 0          | 0          |
| work | ULS02:element<br>results | Tue<br>Jan<br>8<br>2013  |          |           |            |            |
|      | N                        | V2                       | V3       | т         | M2         | M3         |
| N°   | KN                       | KN                       | KN       | KN m      | KN m       | KN m       |
| 417  | 4.884                    | 0                        | 0        | 0         | 0          | 0          |
| work | ULS03:element<br>results | Tue<br>Jan<br>8<br>2013  |          |           |            |            |
|      | N                        | V2                       | V3       | Т         | M2         | M3         |
| N°   | KN                       | KN                       | KN       | KN m      | KN m       | KN m       |
| 417  | 5.233                    | 0                        | 0        | 0         | 0          | 0          |

# Edge Cable Type E01 Repot

| work | SLS01:element<br>results | Mon<br>Jan<br>7<br>2013 |    |      |      |      |
|------|--------------------------|-------------------------|----|------|------|------|
|      | N                        | V2                      | V3 | т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 369  | 0.539                    | 0                       | 0  | 0    | 0    | 0    |
| 370  | 0.403                    | 0                       | 0  | 0    | 0    | 0    |
| 371  | 0.344                    | 0                       | 0  | 0    | 0    | 0    |
| 372  | 0.312                    | 0                       | 0  | 0    | 0    | 0    |
| 373  | 0.296                    | 0                       | 0  | 0    | 0    | 0    |
| 374  | 0.295                    | 0                       | 0  | 0    | 0    | 0    |
| 375  | 0.313                    | 0                       | 0  | 0    | 0    | 0    |
| 376  | 0.355                    | 0                       | 0  | 0    | 0    | 0    |
| 377  | 0.456                    | 0                       | 0  | 0    | 0    | 0    |
| work | SLS02:element<br>results | Mon<br>Jan<br>7<br>2013 |    |      |      |      |
|      | N                        | V2                      | V3 | Т    | M2   | M3   |
| N°   | KN                       | KN                      | KN | KN m | KN m | KN m |
| 369  | 7.262                    | 0                       | 0  | 0    | 0    | 0    |
| 370  | 6.377                    | 0                       | 0  | 0    | 0    | 0    |

| 371   | 5.48  | 0  | 0   | 0  | 0   | 0   |
|---|---|--|---|--|---|---|
| 372   | 4.859   | 0  | 0   | 0  | 0   | 0   |
| 373   | 4.517   | 0  | 0   | 0  | 0   | 0   |
| 374   | 4.449   | 0  | 0   | 0  | 0   | 0   |
| 375   | 4.673   | 0  | 0   | 0  | 0   | 0   |
| 376   | 5.244   | 0 0  |   | 0  | 0   | 0   |
| 377   | 6.043   | 0  | 0   | 0  | 0   | 0   |
|   |   | Mon  |   |  |   |   |
|   | SI S03 element  | Jan<br>7   |   |  |   |   |
| work  | results   | 2013   |   |  |   |   |
|   | N   | V2   | V3  | Т  | M2  | M3  |
| N°  | KN  | KN   | KN  | KN m   | KN m  | KN m  |
| 369   | 7.374   | 0  | 0   | 0  | 0   | 0   |
| 370   | 6.429   | 0  | 0   | 0  | 0   | 0   |
| 371   | 5.491   | 0  | 0   | 0  | 0   | 0   |
| 372   | 4.825   | 0  | 0   | 0  | 0   | 0   |
| 373   | 4.483   | 0  | 0   | 0  | 0   | 0   |
| 374   | 4.429   | 0  | 0   | 0  | 0   | 0   |
| 375   | 4.657   | 0  | 0   | 0  | 0   | 0   |
| 376   | 5.202   | 0  | 0   | 0  | 0   | 0   |
| 377   | 5.918   | 0<br>Mon   | 0   | 0  | 0   | 0   |
|   |   | Jan  |   |  |   |   |
| work  | ULS01:element   | 7<br>2013  |   |  |   |   |
| WOIK  | N   | 2013   | 110   |  |   |   |
|   | N   | V2   | V3  | T  | M2  | M3  |
| N°  | KN  | V2<br>KN   | V3<br>KN  | T<br>KN m  | M2<br>KN m  | M3<br>KN m  |
| N°<br>369   | N<br>KN<br>0.545  | V2<br>KN<br>0  | V3<br>KN<br>0   | T<br>KN m<br>0   | M2<br>KN m<br>0   | M3<br>KN m<br>0   |
| N°<br>369<br>370  | N<br>KN<br>0.545<br>0.409   | V2<br>KN<br>0<br>0   | V3<br>KN<br>0<br>0  | T<br>KN m<br>0<br>0  | M2<br><u>KN m</u><br>0<br>0   | M3<br>KN m<br>0<br>0  |
| N°<br>369<br>370<br>371   | N<br>KN<br>0.545<br>0.409<br>0.35   | V2<br>KN<br>0<br>0   | V3<br>KN<br>0<br>0  | T<br>KN m<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0  | M3<br>KN m<br>0<br>0<br>0   |
| N°<br>369<br>370<br>371<br>372  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317  | V2<br>KN<br>0<br>0<br>0  | V3<br>KN<br>0<br>0<br>0   | T<br>KN m<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0  |
| N°           369           370           371           372           373  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301   | V2<br>KN<br>0<br>0<br>0<br>0   | V3<br>KN<br>0<br>0<br>0<br>0  | T<br>KN m<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0  | M3<br>KN m<br>0<br>0<br>0<br>0<br>0   |
| N°           369           370           371           372           373           374  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301  | V2<br>KN<br>0<br>0<br>0<br>0<br>0  | V3<br>KN<br>0<br>0<br>0<br>0<br>0   | T<br>KN m<br>0<br>0<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0                                    |
| N°           369           370           371           372           373           374           375  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.3<br>0.3   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0   | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0                                    | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M3<br><u>KN m</u><br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0              |
| N°           369           370           371           372           373           374           375           376  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.3<br>0.317<br>0.36   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     |
| №           369           370           371           372           373           374           375           376           377   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.3<br>0.317<br>0.36<br>0.462  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0      |
| N°           369           370           371           372           373           374           375           376           377  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.36   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| <ul> <li>№</li> <li>369</li> <li>370</li> <li>371</li> <li>372</li> <li>373</li> <li>374</li> <li>375</li> <li>376</li> <li>377</li> </ul>  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| N°           369           370           371           372           373           374           375           376           377           work   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                |
| N°         369         370         371         372         373         374         375         376         377         work   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0           | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| N°           369           370           371           372           373           374           375           376           377           work           N°           369  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| N°           369           370           371           372           373           374           375           376           377           work           N°           369           370  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN<br>10.035<br>8 920  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| N°           369           370           371           372           373           374           375           376           377           work           N°           369           370  | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN<br>KN<br>10.035<br>8.929<br>7 726   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           370   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN<br>10.035<br>8.929<br>7.726<br>6.855   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           370           371           375           376           377           work           N°           369           370           371           372           373   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN<br>10.035<br>8.929<br>7.726<br>6.855<br>6.361   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           370           371           375           376           377           work           N°           369           370           371           372           373           374   | N<br>KN<br>0.545<br>0.409<br>0.35<br>0.317<br>0.301<br>0.301<br>0.317<br>0.36<br>0.462<br>ULS02:element<br>results<br>N<br>KN<br>10.035<br>8.929<br>7.726<br>6.855<br>6.361<br>6.255  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           370           371           375           376           377           work           N°           369           370           371           372           373           374           375   | N         KN         0.545         0.409         0.35         0.317         0.301         0.302         0.303         0.301         0.301         0.302         0.303         0.301         0.302         N         KN         10.035         8.929         7.726         6.855         6.361         6.255         6.361   | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           377           work           N°           369           370           371           372           373           371           372           373           374           375           370           371           372           373           374           375           376   | N         KN         0.545         0.409         0.35         0.317         0.301         0.302         0.462         VLS02:element<br>results         N         KN         10.035         8.929         7.726         6.855         6.361         6.255         6.559         7.328  | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| №           369           370           371           372           373           374           375           376           377           work           N°           369           370           371           375           376           377           work           N°           369           370           371           372           373           371           372           373           371           372           373           374           375           376           371           372           373           374           375           376           376           376           376 | N         KN         0.545         0.409         0.35         0.317         0.301         0.462         N         KN         10.035         8.929         7.726         6.855         6.361         6.255         6.559         7.328         8.348 | V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |

| work | ULS03:element<br>results | 7<br>2013 |    |      |      |      |
|------|--------------------------|-----------|----|------|------|------|
|      | N                        | V2        | V3 | т    | M2   | M3   |
| N°   | KN                       | KN        | KN | KN m | KN m | KN m |
| 369  | 10.159                   | 0         | 0  | 0    | 0    | 0    |
| 370  | 8.971                    | 0         | 0  | 0    | 0    | 0    |
| 371  | 7.718                    | 0         | 0  | 0    | 0    | 0    |
| 372  | 6.784                    | 0         | 0  | 0    | 0    | 0    |
| 373  | 6.295                    | 0         | 0  | 0    | 0    | 0    |
| 374  | 6.212                    | 0         | 0  | 0    | 0    | 0    |
| 375  | 6.525                    | 0         | 0  | 0    | 0    | 0    |
| 376  | 7.258                    | 0         | 0  | 0    | 0    | 0    |
| 377  | 8.162                    | 0         | 0  | 0    | 0    | 0    |

# Stay Cable Type E02 Report

| NomeNo  | work  | SLS01:element  | Jan<br>7<br>2013  |   |   |  |   |
|---|---|--|---|---|---|--|---|
| NNNNNNNNIIINNIIINNIIINNIIINNIIINNIIINNIIINNIIINNIIINNIIINNIII3871.00000000003880.651000000003910.462000000003920.451000000003930.629000000003940.611000000003950.6290000000003940.62900 <th>NIO</th> <th>N</th> <th>V2</th> <th>V3</th> <th>T</th> <th>M2</th> <th>M3</th>  | NIO   | N  | V2  | V3  | T   | M2   | M3  |
| 3880.10000003880.65000003900.547000003910.462000003930.659000003940.514000003950.629000003960.512000003977.8127M2M3M33872.155000003881.728000003910.965000003920.881000003930.867000003940.925000003951.165000003940.925000003951.165000003961.16500000397NKNKNKNKNKN3981.165000003991.165000003911.64000003930.65100000 <td< td=""><td>N<br/>387</td><td>1.09</td><td></td><td></td><td></td><td></td><td></td></td<>  | N<br>387  | 1.09   |   |   |   |  |   |
| abic<br>389abic<br>300abic<br>300abic<br>300abic<br>300abic<br>300abic<br>300abic<br>300abic<br>300abic<br>   | 388   | 0.811  | 0   | 0   | 0   | 0  | 0   |
| 1000<br>3000.0547<br>0.00000003910.4820000003920.4510000003940.5420000003950.6290000003860.6290000003872.1550000003881.7280000003910.9660000003920.8810000003930.8670000003940.9260000003930.8670000003940.9260000003951.1650000003961.1270000003971.16500000003981.16500000003991.16500000003981.46300000003991.647000000 <td>389</td> <td>0.65</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>  | 389   | 0.65   | 0   | 0   | 0   | 0  | 0   |
| 1000         0         0         0         0         0         0         0           391         0.452         0         0         0         0         0         0           393         0.459         0         0         0         0         0         0           394         0.514         0         0         0         0         0         0         0           395         0.629         0         0         0         0         0         0         0           395         0.629         0         0         0         0         0         0         0           395         0.629         0         0         0         0         0         0         0           387         7.2155         0   | 390   | 0.547  | 0   | 0   | 0   | 0  | 0   |
| 1000000000000000000000000000000000000   | 391   | 0.482  | 0   | 0   | 0   | 0  | 0   |
| 333         0.459         0         0         0         0         0         0           394         0.514         0         0         0         0         0         0           395         0.629         0         0         0         0         0         0           395         0.629         0         0         0         0         0         0           SLS02/element         7         results         2013          N         KN         KN         KN         KN         KN         KN         KN         M         MN  | 392   | 0.451  | 0   | 0   | 0   | 0  | 0   |
| 3940.514000003950.629000003950.629000003872.155000003881.728000003911.362000003920.965000003930.965000003940.965000003951.165000003940.925000003951.165000003961.46000003972.273000003881.482000003951.165000003961.484000003981.483000003991.246000003911.647000003930.963000003941.647000003951.457000003961.64700000 <td>393</td> <td>0.459</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>  | 393   | 0.459  | 0   | 0   | 0   | 0  | 0   |
| 3950.6.2900000Mon<br>resultsMon<br>7<br>2013NMon<br>7<br>2013NMon<br>NNMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>NMon<br>N   | 394   | 0.514  | 0   | 0   | 0   | 0  | 0   |
| Man<br>results         Man<br>2013         Man<br>2013           N         N         N         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         KN         KN            | 395   | 0.629  | 0   | 0   | 0   | 0  | 0   |
| N         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         KN           387         2.155         0         0         0         0         0           388         1.728         0         0         0         0         0         0           389         1.332         0         0         0         0         0         0         0           391         0.965         0         0         0         0         0         0         0           392         0.861         0         0         0         0         0         0         0         0           393         0.867         0         0         0         0         0         0         0           393         0.867         0  | work  | SLS02:element  | Mon<br>Jan<br>7<br>2013   |   |   |  |   |
| N°KNKNKNKNKNKN3872.155000003881.728000003901.127000003910.965000003920.881000003930.867000003940.925000003951.165000003961.16200000397results2037M2M3N°KNKNKNKNKNKN3872.273000003931.4830000003941.4810000003951.4820000003961.4830000003971.4830000003981.6470000003930.6530000003941.0320000003951.6410000003960.65200000   |   | N  | V2  | V3  | Т   | M2   | M3  |
| 3872.155000003881.728000003901.132000003910.966000003920.881000003930.867000003940.925000003951.165000003961.165000003972.273000003881.842000003941.483000003951.165000003981.483000003911.047000003930.963000003941.032000003951.311000003960.540000003960.540000003971.3110000003980.6520000003990.5480000003990.5480   | N°  | KN   | KN  | KN  | KN m  | KN m   | KN m  |
| 3881.728000003991.3820000003910.9650000003920.8810000003930.8670000003940.9250000003951.1650000003961.165000000397SLS03:element<br>results2013TM2M3N°KNKNKNKNKN03881.842000003991.483000003911.047000003920.961000003930.953000003941.032000003951.311000003951.3110000003960.6520000003950.6520000003960.6540000003960.6270000003970.652 <td< td=""><td>387</td><td>2.155</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></td<>   | 387   | 2.155  | 0   | 0   | 0   | 0  | 0   |
| 3891.382000003901.1270000003910.9650000003920.8810000003930.8670000003940.9250000003951.1650000003961.1650000003972.2730000003881.8420000003901.2160000003911.0470000003920.9610000003930.9530000003941.0320000003951.3110000003960.510000003971.0960000003980.6520000003990.6540000003910.4830000003930.65200  | 388   | 1.728  | 0   | 0   | 0   | 0  | 0   |
| 3901.1270000003910.965000003920.881000003930.867000003940.925000003951.165000003951.165203003951.165000003961.165203MM3972.273000003881.842000003901.216000003911.047000003920.961000003930.953000003941.032000003951.311000003961.311000003971.096000003980.652000003990.654000003910.483000003930.654000003940.65400000 <td>389</td> <td>1.382</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>  | 389   | 1.382  | 0   | 0   | 0   | 0  | 0   |
| 3910.965000003920.881000003930.867000003940.925000003951.165000003951.165000003951.165000003951.165000003872.273000003881.842000003891.483000003911.047000003920.961000003930.953000003941.032000003951.311000003941.032000003951.311000003951.311000003960.51000003971.311000003980.652000003990.548000003910.465200000 <td>390</td> <td>1.127</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td> <td>0</td>   | 390   | 1.127  | 0   | 0   | 0   | 0  | 0   |
| 3920.881000003930.867000003940.925000003951.165000003951.165000003951.165000003951.165737100003951.1657371001001003961.2273000003881.842000003901.216000003911.047000003930.953000003941.032000003930.953000003941.032000003871.096000003880.815000003940.548000003950.627000003930.652000003940.548000003950.627000003960.6270000 <t< td=""><td>391</td><td>0.965</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></t<>  | 391   | 0.965  | 0   | 0   | 0   | 0  | 0   |
| 3930.867000003940.9250000003951.1650000003951.1650000003961.16520135555workKNKNKNKNKNKN63872.2730000003881.8420000003901.2160000003911.0470000003930.9530000003941.0320000003951.3110000003951.3110000003961.311000000397KNKNKNKNKNKNKN3980.6520000003951.31100000003960.3110000000397KNKNKNKNKNKNKNKN3980.652000000039   | 392   | 0.881  | 0   | 0   | 0   | 0  | 0   |
| 3940.0925000003951.165000003961.16500000397SLS03:element 7<br>results2013TM2M3N°KNKNKNKNKN63872.273000003881.842000003931.483000003941.047000003930.953000003941.032000003951.311000003951.311000003961.31100000397KNKNKNKNKNKN3980.652000003951.311000000395000000003960.6520000003971.0960000003980.6520000003990.5480000003910.54800000 <t< td=""><td>393</td><td>0.867</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></t<>  | 393   | 0.867  | 0   | 0   | 0   | 0  | 0   |
| 3951.16500000SLS03:element 7<br>resultsVV2V3TM2M3N°KNKNKNKNKNKNM33872.273000003881.8420000003891.483000003901.216000003911.047000003920.961000003930.953000003941.032000003951.311000003961.62120000003970.518000003980.652000003991.034000003911.035000003920.451000003930.815000003940.652000003930.459000003940.513000003950.627000003950.627 <t< td=""><td>394</td><td>0.925</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></t<>  | 394   | 0.925  | 0   | 0   | 0   | 0  | 0   |
| Mon<br>results         Non<br>results         Non<br>results           N°         N         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         KN         M3           387         2.273         0         0         0         0         0         0           388         1.842         0         00         0         0         0         0           389         1.483         0         00         0         0         0         0           390         1.216         0         0         0         0         0         0           391         1.047         0         0         0         0         0         0           392         0.961         0         0         0         0         0         0         0           393         0.953         0 <th< td=""><td>395</td><td>1.165</td><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td></th<>   | 395   | 1.165  | 0   | 0   | 0   | 0  | 0   |
| N°NAV2V3TM2M3N°KNKNKNKNKNKN3872.273000003881.842000003891.4830000003901.2160000003911.0470000003920.9610000003930.9530000003941.0320000003951.3110000003961.311000000397NortKNKNKNKNKNKN3980.652000003990.6520000003910.4830000003930.6520000003940.5130000003950.6270000003950.627000000395NXNKNKNKNKNKN395NXNKNKNKNKN <th>work</th> <th>SLS03:element<br/>results</th> <th>Jan<br/>7<br/>2013</th> <th></th> <th></th> <th></th> <th></th>  | work  | SLS03:element<br>results   | Jan<br>7<br>2013  |   |   |  |   |
| N°         KN         KN         KN m         KN m         KN m         KN m           387         2.273         0         0         0         0         0           388         1.842         0         0         0         0         0           389         1.483         0         0         0         0         0           390         1.216         0         0         0         0         0           391         1.047         0         0         0         0         0           392         0.961         0         0         0         0         0           393         0.953         0         0         0         0         0           394         1.032         0         0         0         0         0           395         1.311         0         0         0         0         0           395         1.311         0         0         0         0         0           396         KN         KN         KN         KN         KN         KN         M           393         0.652         0         0         0  |   | Ν  | V2  | V3  | T   | M2   | 140   |
| 367         2.2.73         00         <   | N19   | IZNI.  | IZNI  | IZNI.   | KNm   |  | IVI3  |
| 380         1.842         0<  | <mark>N°</mark><br>387  | KN 2 273   | KN  | KN  | KN m  | KN m   | KN m  |
| No         No<  | N°<br>387<br>388  | KN<br>2.273<br>1 842   | KN<br>0   | KN<br>0   | KN m<br>0   | KN m<br>0  | KN m<br>0   |
| 391         1.047         0 </td <td>N°<br/>387<br/>388<br/>389</td> <td>KN<br/>2.273<br/>1.842<br/>1.483</td> <td>KN<br/>0<br/>0</td> <td>KN<br/>0<br/>0</td> <td>KN m<br/>0<br/>0</td> <td>KN m<br/>0<br/>0</td> <td>KN m<br/>0<br/>0</td>  | N°<br>387<br>388<br>389   | KN<br>2.273<br>1.842<br>1.483  | KN<br>0<br>0  | KN<br>0<br>0  | KN m<br>0<br>0  | KN m<br>0<br>0   | KN m<br>0<br>0  |
| 392         0.961         0 </td <td>N°<br/>387<br/>388<br/>389<br/>390</td> <td>KN<br/>2.273<br/>1.842<br/>1.483<br/>1.216</td> <td>KN<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0</td>  | N°<br>387<br>388<br>389<br>390  | KN<br>2.273<br>1.842<br>1.483<br>1.216   | KN<br>0<br>0<br>0   | KN<br>0<br>0<br>0   | KN m<br>0<br>0<br>0   | KN m<br>0<br>0<br>0  | KN m<br>0<br>0<br>0   |
| 393         0.953         0         0         0         0         0           394         1.032         0         0         0         0         0         0           395         1.311         0         0         0         0         0         0           395         1.311         0         0         0         0         0         0           work         ULS01:element<br>results         7<br>2013         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         MN         M         M         M         M         M         M3         M3           387         1.096         0  | N°<br>387<br>388<br>389<br>390<br>391   | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047  | KN<br>0<br>0<br>0<br>0  | KN<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0  |
| 394       1.032       0       0       0       0       0         395       1.311       0       0       0       0       0       0         395       1.311       0       0       0       0       0       0       0         work       VLS01:element       7<br>2013       2013       T       M2       M3         N°       KN       KN       KN       KN       KN       KN       KN       M3         387       1.096       0       0       0       0       0       0         388       0.815       0       0       0       0       0       0       0         389       0.652       0 <td>N°<br/>387<br/>388<br>389<br/>390<br/>391<br/>392</br></td> <td>KN<br/>2.273<br/>1.842<br/>1.483<br/>1.216<br/>1.047<br/>0.961</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>  | N°<br>387<br>388<br>  | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961   | KN<br>0<br>0<br>0<br>0<br>0   | KN<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0  |
| 3951.31100000Jan<br>Jan<br>VerJan<br>7<br>results77777workN2013TM2M3N°KNKNKNKNmKNmKNm3871.096000003880.815000003890.652000003900.548000003910.483000003930.459000003940.627000003950.62770000100JanJanJanJanJanJan101N°KNKNKNKNKNKNKNN°KNKNKNKNKNKNKNKN   | N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393   | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961<br>0.953  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| Mon<br>Jan<br>7<br>2013         Mon<br>2013           Work         N         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         M0         M3           387         1.096         0         0         0         0         0         0           388         0.815         0         0         0         0         0         0           389         0.652         0         0         0         0         0         0           390         0.548         0         0         0         0         0         0           391         0.483         0         0         0         0         0         0           392         0.452         0         0         0         0         0         0           393         0.459         0         0         0         0         0         0           394         0.513         0         0         0         0         0         0           395         0.627         0         0         0         0         0         0           work   | №           387           388           389           390           391           392           393           394   | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961<br>0.953<br>1.032   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| N°         N (N)         V2         V3         T         M2         M3           N°         KN         KN         KN         KN         KN         KN         KN           387         1.096         0         0         0         0         0         0           388         0.815         0         0         0         0         0         0           389         0.652         0         0         0         0         0         0           390         0.548         0         0         0         0         0         0           391         0.483         0         0         0         0         0         0           392         0.452         0         0         0         0         0         0           393         0.459         0         0         0         0         0         0           394         0.513         0         0         0         0         0         0         0         0           395         0.627         0         0         0         0         0         0         0         0         0         0  | N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393<br>393<br>394<br>395  | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961<br>0.953<br>1.032<br>1.311  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                                    | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  |
| N°         KN         KN         KN m         KN m         KN m         KN m         KN m           387         1.096         0         0         0         0         0         0           388         0.815         0         0         0         0         0         0           389         0.652         0         0         0         0         0         0           390         0.548         0         0         0         0         0         0           391         0.483         0         0         0         0         0         0           392         0.452         0         0         0         0         0         0           393         0.459         0         0         0         0         0         0           394         0.513         0         0         0         0         0         0           395         0.627         0         0         0         0         0         0           work         KN         KN         KN         KN         KN         KN         KN         KN  | N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393<br>394<br>395   | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961<br>0.953<br>1.032<br>1.311  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  |
| 387       1.096       0       0       0       0       0         388       0.815       0       0       0       0       0         389       0.652       0       0       0       0       0         390       0.548       0       0       0       0       0         391       0.483       0       0       0       0       0         392       0.452       0       0       0       0       0         393       0.459       0       0       0       0       0         394       0.513       0       0       0       0       0       0         395       0.627       0       0       0       0       0       0       0         work       V2       V3       T       M2       M3         N°       KN  | N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393<br>394<br>395<br>work   | KN<br>2.273<br>1.842<br>1.483<br>1.216<br>1.047<br>0.961<br>0.953<br>1.032<br>1.311<br>ULS01:element<br>results<br>N   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 388         0.815         0 </td <td>N°         387         388         389         390         391         392         393         394         395         work         N°</td> <td>KN         2.273         1.842         1.216         1.216         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N<br/>KN</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>M2<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | N°         387         388         389         390         391         392         393         394         395         work         N°  | KN         2.273         1.842         1.216         1.216         0.961         0.953         1.032         1.311         ULS01:element<br>results         N<br>KN  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 389         0.652         0 </td <td>N°<br/>387<br/>388<br/>390<br/>391<br/>392<br/>393<br/>394<br/>395<br/>Vork<br/>N°<br/>387</td> <td>KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N<br/>KN         1.096</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>M2<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | N°<br>387<br>388<br>390<br>391<br>392<br>393<br>394<br>395<br>Vork<br>N°<br>387   | KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N<br>KN         1.096  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 390         0.548         0 </td <td>№           387           388           389           390           391           392           393           394           395           work           N°           387</td> <td>KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N         KN         1.096         0.815</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | №           387           388           389           390           391           392           393           394           395           work           N°           387   | KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N         KN         1.096         0.815   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 391         0.483         0 </td <td>N°         387         388         389         390         391         392         393         394         395         work         N°         387         388         393         394         395         395         395         395         395         395         395         395</td> <td>KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N         KN         1.096         0.815         0.652</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>M2<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | N°         387         388         389         390         391         392         393         394         395         work         N°         387         388         393         394         395         395         395         395         395         395         395         395  | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N         KN         1.096         0.815         0.652   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 392         0.452         0 </td <td>№           387           388           389           390           391           392           393           394           395           work           N°           388           389           393           394           395           Work           N°           387           388           389           390</td> <td>KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N         KN         0.9652         0.652         0.548</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>M2<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | №           387           388           389           390           391           392           393           394           395           work           N°           388           389           393           394           395           Work           N°           387           388           389           390   | KN         2.273         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N         KN         0.9652         0.652         0.548  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 393         0.459         0 </td <td>N°         387         388         389         390         391         392         393         394         395         work         N°         388         389         394         395         394         395         394         395         394         395         394         395         395         396         397         388         389         390         391         392         393         393         391</td> <td>KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br/>results         N         KN         0.953         0.815         0.652         0.548         0.483</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>M2<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td>   | N°         387         388         389         390         391         392         393         394         395         work         N°         388         389         394         395         394         395         394         395         394         395         394         395         395         396         397         388         389         390         391         392         393         393         391  | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N         KN         0.953         0.815         0.652         0.548         0.483   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 394     0.513     0     0     0     0     0       395     0.627     0     0     0     0     0       395     0.627     0     0     0     0     0     0       395     0.627     0     0     0     0     0     0       395     0.627     0     0     0     0     0       Work     VLS02:element     7     2013       N°     KN     KN     KN     KN     KN   | №           387           388           389           390           391           392           393           394           395           work           N°           388           389           391           392           393           394           395           394           395           394           395           394           395           395           388           388           388           388           388           388           389           391           392           391           392   | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element results         N         KN         0.815         0.652         0.548         0.452  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| S95         0.027         0 </td <td>№           387           388           389           390           391           392           393           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           388           389           390           391           392           393           391           392           393           392           393           392           393           392           393           393</td> <td>KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         VLS01:element<br/>results         N         KN         0.953         0.452         0.452         0.459</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> <td>MS<br/>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td> | №           387           388           389           390           391           392           393           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           394           395           388           389           390           391           392           393           391           392           393           392           393           392           393           392           393           393 | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         VLS01:element<br>results         N         KN         0.953         0.452         0.452         0.459   | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| WorkULS02:element<br>results7<br>2013N°KNKNKNKNN°KNKNKNKN   | N°         387         388         389         390         391         392         393         394         395         Work         N°         388         389         394         395         394         395         394         395         394         395         394         395         387         388         389         390         391         392         393         394         395         391         392         393         394         395  | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element results         N         KN         0.815         0.652         0.548         0.452         0.452         0.453  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m         0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0       |
| $N^{\circ}$ KN KN KN KN KN KN KN  | №           387           388           389           390           391           392           393           394           395           394           395           388           394           395           394           395           394           395           394           395           394           395           388           389           388           389           391           388           389           391           392           393           391           392           393           391           392           393           394           395   | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element results         N         KN         0.815         0.652         0.548         0.459         0.513         0.627  | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
|   | N°         387         389         389         390         391         392         393         394         395         Work         387         388         389         394         395         Work         387         388         389         390         391         387         388         389         390         391         392         393         394         395         Work         395         work  | KN         2.273         1.842         1.842         1.483         1.216         1.047         0.961         0.953         1.032         1.311         ULS01:element<br>results         N         KN         0.953         0.652         0.652         0.453         0.452         0.452         0.452         0.452         0.453         0.513         0.627 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | MS<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |

| 387  | 2.821  | 0  | 0  | 0  | 0  | 0   |
|--|--|--|--|--|--|---|
| 388  | 2.305  | 0  | 0  | 0  | 0  | 0   |
| 389  | 1.852  | 0  | 0  | 0  | 0  | 0   |
| 390  | 1.5  | 0  | 0  | 0  | 0  | 0   |
| 391  | 1.268  | 0  | 0  | 0  | 0  | 0   |
| 392  | 1.144  | 0  | 0  | 0  | 0  | 0   |
| 393  | 1.108  | 0  | 0  | 0  | 0  | 0   |
| 394  | 1.171  | 0  | 0  | 0  | 0  | 0   |
| 395  | 1.479  | 0  | 0  | 0  | 0  | 0   |
|  | ULS03:element  | Jan<br>7   |  |  |  |   |
| work   | results  | 2013   |  |  |  |   |
| work   | results<br>N   | 2013<br>V2   | V3   | Т  | M2   | M3  |
| work<br>N°   | results<br>N<br>KN   | 2013<br>V2<br>KN   | V3<br>KN   | T<br>KN m  | M2<br>KN m   | M3<br>KN m  |
| work<br>N°<br>387  | results<br>N<br>KN<br>2.901  | 2013<br>V2<br>KN<br>0                                    | V3<br>KN<br>0                                    | T<br>KN m<br>0   | M2<br>KN m<br>0                                    | M3<br>KN m<br>0   |
| work<br>N°<br>387<br>388   | results<br>N<br>KN<br>2.901<br>2.387   | 2013<br>V2<br>KN<br>0<br>0                               | V3<br>KN<br>0<br>0                               | T<br>KN m<br>0<br>0                                    | M2<br>KN m<br>0<br>0                               | M3<br>KN m<br>0<br>0                                    |
| work N° 387 388 389  | results<br>N<br>KN<br>2.901<br>2.387<br>1.929  | 2013<br>V2<br>KN<br>0<br>0                               | V3<br>KN<br>0<br>0                               | T<br>KN m<br>0<br>0                                    | M2<br>KN m<br>0<br>0                               | M3<br>KN m<br>0<br>0                                    |
| work N° 387 388 389 390  | results<br>N<br>KN<br>2.901<br>2.387<br>1.929<br>1.571                                     | 2013<br>V2<br>KN<br>0<br>0<br>0                          | V3<br>KN<br>0<br>0<br>0                          | T<br>KN m<br>0<br>0<br>0                               | M2<br>KN m<br>0<br>0<br>0                          | M3<br>KN m<br>0<br>0<br>0                               |
| work<br>N°<br>387<br>388<br>389<br>390<br>391                      | results<br>N<br>KN<br>2.901<br>2.387<br>1.929<br>1.571<br>1.339                            | 2013<br>V2<br>KN<br>0<br>0<br>0<br>0                     | V3<br>KN<br>0<br>0<br>0<br>0                     | T<br>KN m<br>0<br>0<br>0<br>0                          | M2<br>KN m<br>0<br>0<br>0<br>0                     | M3<br>KN m<br>0<br>0<br>0<br>0<br>0                     |
| work<br>N°<br>387<br>388<br>389<br>390<br>391<br>392               | results<br>N<br>KN<br>2.901<br>2.387<br>1.929<br>1.571<br>1.339<br>1.217                   | 2013<br>V2<br>KN<br>0<br>0<br>0<br>0<br>0                | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0           | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0                | M2<br>KN m<br>0<br>0<br>0<br>0<br>0                | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0                |
| work<br>N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393        | results<br>N<br>KN<br>2.901<br>2.387<br>1.929<br>1.571<br>1.339<br>1.217<br>1.194          | 2013<br>V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0      | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0      | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0           | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0      | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0           |
| work<br>N°<br>387<br>388<br>389<br>390<br>391<br>392<br>393<br>393 | results<br>N<br>KN<br>2.901<br>2.387<br>1.929<br>1.571<br>1.339<br>1.217<br>1.194<br>1.284 | 2013<br>V2<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | T<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M3<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |

# Stay Cable Type E03 Report

| work   | SLS01:element<br>results   | Jan<br>7<br>2013  |   |  |   |   |
|--|--|---|---|--|---|---|
|  | N  | V2  | V3  | Т  | M2  | M3  |
| N°   | KN   | KN  | KN  | KN m   | KN m  | KN m  |
| 351  | 0.921  | 0   | 0   | 0  | 0   | 0   |
| 352  | 0.679  | 0   | 0   | 0  | 0   | 0   |
| 353  | 0.547  | 0   | 0   | 0  | 0   | 0   |
| 354  | 0.476  | 0   | 0   | 0  | 0   | 0   |
| 355  | 0.452  | 0   | 0   | 0  | 0   | 0   |
| 356  | 0.466  | 0   | 0   | 0  | 0   | 0   |
| 357  | 0.519  | 0   | 0   | 0  | 0   | 0   |
| 358  | 0.612  | 0   | 0   | 0  | 0   | 0   |
| 359  | 0.763  | 0   | 0   | 0  | 0   | 0   |
| work   | SLS02:element<br>results   | Mon<br>Jan<br>7<br>2013   |   |  |   |   |
|  | N  | V2  | V3  | Т  | M2  | M3  |
| N°   | KN   | KN  | KN  | KN m   | KN m  | KN m  |
| 351  | 1.514  | 0   | 0   | 0  | 0   | 0   |
| 352  | 1.197  | 0   | 0   | 0  | 0   | 0   |
| 353  | 0.969  | 0   | 0   | 0  | 0   | 0   |
| 354  |  |   |   | v  | 0   | 0   |
| 001  | 0.833  | 0   | 0   | 0  | 0   | 0   |
| 355  | 0.833<br>0.787   | 0   | 0<br>0  | 0  | 0   | 0   |
| 355<br>356   | 0.833<br>0.787<br>0.807  | 0<br>0<br>0   | 0<br>0<br>0   | 0<br>0<br>0  | 0<br>0<br>0   | 0<br>0<br>0   |
| 355<br>356<br>357  | 0.833<br>0.787<br>0.807<br>0.877   | 0<br>0<br>0<br>0  | 0<br>0<br>0   | 0<br>0<br>0<br>0   | 0<br>0<br>0<br>0  | 0<br>0<br>0<br>0                                    |
| 355<br>356<br>357<br>358   | 0.833<br>0.787<br>0.807<br>0.877<br>0.999  | 0<br>0<br>0<br>0  | 0<br>0<br>0<br>0                                    | 0<br>0<br>0<br>0<br>0  | 0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0                               |
| 355<br>356<br>357<br>358<br>359                                    | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302   | 0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0                               | 0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0  | 0<br>0<br>0<br>0<br>0<br>0                          |
| 355<br>356<br>357<br>358<br>359<br>work                            | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results                                       | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>7<br>2013           | 0<br>0<br>0<br>0<br>0                               |  |   |   |
| 355<br>356<br>357<br>358<br>359<br>work                            | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results<br>N                                  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>2013           | 0<br>0<br>0<br>0<br>0                               | 0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0  | 0<br>0<br>0<br>0<br>0<br>0                          |
| 355<br>356<br>357<br>358<br>359<br>work                            | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results<br>N<br>KN                            | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>2013<br>2013             | 0<br>0<br>0<br>0<br>0<br>0<br>0                     | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |
| 355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351               | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results<br>N<br>KN<br>1.708                   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>2013<br>2013<br>2013          | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0           | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                               | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0      |
| 355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352        | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results<br>N<br>KN<br>1.708<br>1.374          | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>2013<br>2013<br>2013<br>2013<br>20 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0      | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | M2<br>KN m<br>0<br>0  | M3<br>KN m<br>0<br>0                                |
| 355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352<br>353 | 0.833<br>0.787<br>0.807<br>0.877<br>0.999<br>1.302<br>SLS03:element<br>results<br>N<br>KN<br>1.708<br>1.374<br>1.129 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>2013<br>2013<br>2013<br>2013<br>20 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | С<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0                           | M3<br>KN m<br>0<br>0<br>0<br>0<br>0                 |

| 355   | 0.919  | 0   | 0  | 0  | 0   | 0   |
|---|--|---|--|--|---|---|
| 356   | 0.932  | 0   | 0  | 0  | 0   | 0   |
| 357   | 1.001  | 0   | 0  | 0  | 0   | 0   |
| 358   | 1.131  | 0   | 0  | 0  | 0   | 0   |
| 359   | 1.461  | 0   | 0  | 0  | 0   | 0   |
| work  | ULS01:element<br>results   | Mon<br>Jan<br>7<br>2013   |  |  |   |   |
|   | N  | V2  | V3   | Т  | M2  | M3  |
| N°  | KN   | KN  | KN   | KN m   | KN m  | KN m  |
| 351   | 0.922  | 0   | 0  | 0  | 0   | 0   |
| 352   | 0.679  | 0   | 0  | 0  | 0   | 0   |
| 353   | 0.547  | 0   | 0  | 0  | 0   | 0   |
| 354   | 0.476  | 0   | 0  | 0  | 0   | 0   |
| 355   | 0.451  | 0   | 0  | 0  | 0   | 0   |
| 356   | 0.465  | 0   | 0  | 0  | 0   | 0   |
| 357   | 0.517  | 0   | 0  | 0  | 0   | 0   |
| 300   | 0.61   | 0   | 0  | 0  | 0   | 0   |
| 309   | 0.761  | Mon   | 0  | 0  | 0   | 0   |
| work  | ULS02:element<br>results   | Jan<br>7<br>2013  |  |  |   |   |
|   | N  | V2  | V3   | т  | M2  | M3  |
| N°  | KN   | KN  | KN   | KN m   | KN m  | IZNL mo   |
|   |  |   |  |  |   |   |
| 351   | 1.88   | 0   | 0  | 0  | 0   | 0   |
| 351<br>352  | 1.88<br>1.509  | 0   | 0  | 0  | 0   | 0<br>0  |
| 351<br>352<br>353   | 1.88<br>1.509<br>1.226   | 0<br>0<br>0   | 0<br>0<br>0  | 0 0 0  | 0<br>0<br>0   | 0<br>0<br>0   |
| 351<br>352<br>353<br>354  | 1.88<br>1.509<br>1.226<br>1.051  | 0<br>0<br>0<br>0  | 0<br>0<br>0<br>0   | 0<br>0<br>0  | 0<br>0<br>0   | 0<br>0<br>0<br>0  |
| 351<br>352<br>353<br>354<br>355   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986   | 0<br>0<br>0<br>0<br>0   |  | 0<br>0<br>0<br>0<br>0  | 0<br>0<br>0<br>0<br>0   | 0           0           0           0           0           0           0           0           0           0           0   |
| 351<br>352<br>353<br>354<br>355<br>356  | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005  | 0<br>0<br>0<br>0<br>0<br>0  |  | 0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0  | N         0           0         0           0         0           0         0           0         0           0         0           0         0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086   | 0<br>0<br>0<br>0<br>0<br>0<br>0   |  | 0<br>0<br>0<br>0<br>0<br>0<br>0  | 0<br>0<br>0<br>0<br>0<br>0<br>0   | N     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358  | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231  |   |  |  |   | N     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                                    |  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | 0       0 |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     |  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | N     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0                                       |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 |  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | N     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0       0     0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | T  | N III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0  | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN   | 0        | M2<br>KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351  | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127   | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0        | 0        | M1<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>351<br>352  | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738  | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | 0          | M1<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>359<br>work<br>N°<br>351<br>352<br>353                             | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434                                     | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                     | 0        | 0           | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352<br>353<br>354   | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434<br>1.241                            | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | N     0       0     0  | N       0         0       0   | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352<br>353<br>354<br>355                                    | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434<br>1.241<br>1.16                    | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | 0          0          0    <   | M2<br>KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>359<br>work<br>N°<br>351<br>352<br>353<br>354<br>355<br>356        | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434<br>1.241<br>1.16<br>1.168           | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                    | 0         0 <td< td=""><td>N       0         0       0</td><td>KN m<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0<br/>0</td></td<> | N       0         0       0   | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352<br>353<br>354<br>355<br>356<br>357                      | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434<br>1.241<br>1.168<br>1.244          | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                          | N       0         0       0  | N       0         0       0   | KN III<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |
| 351<br>352<br>353<br>354<br>355<br>356<br>357<br>358<br>359<br>work<br>N°<br>351<br>352<br>353<br>354<br>355<br>356<br>355<br>356<br>357<br>358 | 1.88<br>1.509<br>1.226<br>1.051<br>0.986<br>1.005<br>1.086<br>1.231<br>1.593<br>ULS03:element<br>results<br>N<br>KN<br>2.127<br>1.738<br>1.434<br>1.241<br>1.168<br>1.244<br>1.395 | 0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0 | V3<br>V3<br>KN<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0                    | N       0         0       0  | N       0         0       0 | KN m<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0<br>0   |

Appendix 05: Foundation Detail Drawing





66

#### Appendix 05: Structural Calculation

|      | Design           | of the Corn                    | er Plate Cl        | P01             |        |                                  |                    |           | Λ                         |         |               |
|------|------------------|--------------------------------|--------------------|-----------------|--------|----------------------------------|--------------------|-----------|---------------------------|---------|---------------|
|      | Plate si         | ze                             |                    |                 |        |                                  |                    |           | / \                       |         |               |
|      | Here             |                                |                    |                 |        |                                  |                    |           | / \                       |         |               |
|      | F <sub>v</sub> = | 24.5                           | KN/cm <sup>2</sup> | For A36         | steel  |                                  |                    |           | $\backslash$              |         |               |
|      | φ <sub>b</sub> = | 0.75                           |                    |                 |        |                                  |                    |           | V                         |         |               |
|      | I=               | 15.28                          | cm                 |                 |        |                                  |                    |           |                           |         |               |
|      | w=               | 0.121                          | KN/cm              | for fabrio      | с      |                                  |                    |           |                           |         |               |
|      | P=               | 15                             | KN                 | for edge        | cables |                                  |                    |           |                           |         |               |
|      | M1=              | wl²/8                          |                    |                 |        |                                  |                    |           |                           |         |               |
|      | =                | 3.53                           | KN-cm              |                 |        |                                  | <u>3 Ø5mm A307</u> | BOLT      |                           |         |               |
|      | M <sub>2</sub> = | PI/4                           |                    |                 |        |                                  |                    |           | — 153 —                   |         |               |
|      | =                | 57.30                          | KN-cm              |                 |        |                                  |                    |           | 123                       |         |               |
|      | M=               | $M_1 + M_2$                    |                    |                 |        |                                  |                    |           | 20 0                      |         | DE2 090       |
|      | =                | 60.83                          | KN-cm              |                 |        |                                  | PE3 98             | 9 30 60   | -14                       |         | PE3 909       |
|      | Z=               | M/F <sub>v</sub>               |                    |                 |        |                                  |                    | 19        | $- \frac{O_{12}^{9}}{12}$ |         |               |
|      |                  | 2.48                           | cm <sup>3</sup>    |                 |        |                                  | <u>30mm E60 W</u>  | ELD       | $\sim$                    |         | SUMM E60 WELD |
|      | Z=               | bh²/6                          |                    |                 |        |                                  |                    | $\bigvee$ | (@)                       | N       |               |
|      | Assume           | e thichness o                  | of the plate       | e 6mm           |        |                                  |                    |           | M                         |         |               |
|      | b=               | 0.6                            | cm .               |                 |        |                                  |                    |           |                           |         |               |
|      |                  |                                |                    | Use 6cm         |        |                                  |                    |           | ĬĬ                        | DE5 081 |               |
| Then | h=               | 4.98                           | cm                 | Plate           |        |                                  |                    |           |                           | FL3 901 |               |
|      |                  |                                |                    |                 |        |                                  |                    |           | Щ                         |         |               |
|      | Clampi           | ng plate size                  | <b>e</b>           |                 |        |                                  |                    |           |                           |         |               |
|      | F <sub>y</sub> = | 24.5                           | KN/cm <sup>2</sup> | For A36         | steel  |                                  |                    |           |                           |         |               |
|      | I=               | 5                              | cm                 |                 |        |                                  |                    |           |                           |         |               |
|      | w=               | 0.121                          | KN/cm              |                 |        |                                  |                    |           |                           |         |               |
|      | M <sub>n</sub> = | wl²/8                          |                    |                 |        |                                  |                    |           |                           |         |               |
|      |                  | 0.38                           | KN-cm              |                 |        |                                  |                    |           |                           |         |               |
|      | Z=               | M <sub>n</sub> /F <sub>y</sub> | 2                  |                 |        |                                  |                    |           |                           |         |               |
|      |                  | 0.01543                        | cm³                |                 |        |                                  |                    |           |                           |         |               |
|      | Z=               | bh²/6                          |                    |                 |        |                                  |                    |           |                           |         |               |
|      | Assume           | e thichness o                  | of the plate       | e 3mm           |        |                                  |                    |           |                           |         |               |
|      | b=               | 0.3                            | cm                 |                 |        |                                  |                    |           |                           |         |               |
| Then | h=               | 0.56                           | cm                 |                 |        |                                  |                    |           |                           |         |               |
|      | use 2 cr         | n plate                        |                    |                 |        |                                  |                    |           |                           |         |               |
|      | Design           | of bolts in c                  | lamping p          | late            |        |                                  |                    |           |                           |         |               |
|      | besign<br>       | 0 75                           |                    |                 |        |                                  |                    |           |                           |         |               |
|      | $\Psi^{-}$       | 0.75                           |                    | For A30         | 7      |                                  |                    |           |                           |         |               |
|      | F <sub>v</sub> = | 16 5                           | KN/cm <sup>2</sup> | holts           | ,      |                                  |                    |           |                           |         |               |
|      | \ <b>A</b> /=    | 0 121                          | KN/cm              | boits           |        |                                  |                    |           |                           |         |               |
|      |                  | 12 3                           | cm                 |                 |        |                                  |                    |           |                           |         |               |
|      | R, =             | μ* F *Δ                        | CIII               |                 |        |                                  |                    |           |                           |         |               |
|      | Δςςιμηε          | a 3 holts                      |                    |                 |        |                                  |                    |           |                           |         |               |
|      | Load or          | holts= wxl                     |                    | 15              | KN     |                                  |                    |           |                           |         |               |
|      | Load or          | each holts                     | =                  | 0.50            | KN     |                                  |                    |           |                           |         |               |
|      | Then             |                                |                    | 0.50            |        |                                  |                    |           |                           |         |               |
|      | men              | Δ =                            | 0.04               | cm <sup>2</sup> |        |                                  |                    |           |                           |         |               |
|      | Require          | -v.v<br>=h cib be              | 0.04               | cm              |        |                                  |                    |           |                           |         |               |
|      | use 5m           | m holts                        | 0.25               | CIII            |        |                                  |                    |           |                           |         |               |
|      | use sin          | in boits                       |                    |                 |        |                                  |                    |           |                           |         |               |
|      | Design           | of weld on                     | arms               | Fillet typ      | e weld |                                  |                    |           |                           |         |               |
|      | ф=               | 0.75                           |                    |                 |        |                                  |                    |           |                           |         |               |
|      | $F_{E60} =$      | 42                             | KN/cm <sup>2</sup> |                 |        |                                  |                    |           |                           |         |               |
|      | F <sub>w</sub> = | $0.6*F_{E60}$                  |                    |                 |        |                                  |                    |           |                           |         |               |
|      | Design           | strength pe                    | r cm for .3        | cm of weld      | d=     | 0.75*0.6*F <sub>E60</sub> *0.707 | *0.3               |           |                           |         |               |
|      |                  |                                |                    |                 | =      | 4.0 KN/cm                        |                    |           |                           |         |               |
|      | Load or          | n weld=                        | 13                 | KN              |        |                                  |                    |           |                           |         |               |
|      | No. of v         | veld=                          | 2                  |                 |        |                                  |                    |           |                           |         |               |
|      | Load pe          | er weld=                       | 6.5                | KN              |        |                                  |                    |           |                           |         |               |
|      | Require          | ed weld leng                   | th=                | 1.62            | cm     |                                  |                    |           |                           |         |               |

use 3cm weld

#### Design of the tube for edge cable

 $\begin{array}{ccccccc} \text{Load} = & 13 & \text{KN} \\ \text{F}_{\text{y}} = & 24.5 & \text{KN/cm}^2 \\ \text{Area required to resist A} = & 0.53 & \text{cm}^2 \\ \text{Inner dia of the tube for cable end PE03 is} & 1.2 & \text{cm} \\ \text{Then, outer area- inner area} = 0.48 & \text{cm}^2 \\ \text{Thickness t} = & 0.25 & \text{cm} \\ \text{use 0.35cm thick tube} \end{array}$ 

#### Design of the pin in double shear

| Design load<br>Then<br>Area of the p<br>Dia of the pin<br>use 1.2cm pi  | A <sub>sf</sub> =<br>=<br>oin=<br>n d=<br>n               | 15<br>P <sub>d</sub> /( \$\$0.<br>0.83<br>0.42<br>0.73<br>PE 5  | KN<br>6* F <sub>u</sub> )<br>cm <sup>2</sup><br>cm <sup>2</sup><br>cm  |  |            |
|---|---|---|--|--|------------|
| Design of the   | e pin ir  | n bearing   |  |  |            |
| φ=  | 0.75  |   |  |  |            |
| F <sub>y</sub> =  | 24.5  | KN/cm <sup>2</sup>  | ultimate   | stren  | gth        |
| Area in shear   | r   | d <sub>b</sub> *t   |  |  |            |
|   |   | P.=   | φ*1.8* I   | Fy*  |            |
| Design load   |   | ۰a  | d <sub>b</sub> *t  |  |            |
| Design load   |   | 15  | KN   |  |            |
| d <sub>b</sub> =  | 1.2   | cm  |  |  |            |
| Thickness t=  |   | 0.38  | ст   |  |            |
| use 0.6cm th  | ick pla   | te  |  |  |            |
|   |   |   |  |  |            |
| Design of th  | e plate   | e in tensio   | n  |  |            |
| Design of th<br>φ=  | e plate<br>0.75   | e in tensio   | n  |  |            |
| Design of th<br>$\varphi$ =<br>F <sub>u</sub> =   | e plate<br>0.75<br>40                                     | e in tensio<br>KN/cm <sup>2</sup>   | n  |  |            |
| Design of th<br>φ=<br>F <sub>u</sub> =<br>Thickeness t  | e plate<br>0.75<br>40<br>=                                | e in tension<br>KN/cm <sup>2</sup><br>0.6   | n<br>cm  |  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=   | e plate<br>0.75<br>40<br>=                                | e in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2  | n<br>cm<br>cm  |  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load   | e plate<br>0.75<br>40<br>=                                | e in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15  | n<br>cm<br>cm<br>KN  |  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load   | e plate<br>0.75<br>40<br>=                                | e in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>P <sub>t</sub> =  | n<br>cm<br>cm<br>KN<br>φ* F <sub>v</sub> *A  | e .  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi  | e plate<br>0.75<br>40<br>=<br>=                           | KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>P <sub>t</sub> =<br>A <sub>e</sub> =  | n<br>cm<br>cm<br>KN<br>φ* F <sub>v</sub> *A,<br>P <sub>t</sub> /( φ* F   | ≘<br>)<br>2  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi  | e plate<br>0.75<br>40<br>=<br>=                           | E in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>P <sub>t</sub> =<br>A <sub>e</sub> =<br>=   | n<br>cm<br>KN<br>φ* F <sub>v</sub> *A<br>P <sub>t</sub> /(φ* F<br>0.5  | °√)<br>cm²   |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Area in tensi<br>Gross Area  | e plate<br>0.75<br>40<br>=<br>=                           | KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>P <sub>t</sub> =<br>A <sub>e</sub> =<br>=<br>A <sub>g</sub> =                                       | n<br>cm<br>KN<br>φ* F <sub>v</sub> *A<br>P <sub>t</sub> /( φ* F<br>0.5<br>A <sub>e</sub> +(d+.1  | e<br>√)<br>cm²<br>.5)*t  |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi<br>Gross Area  | e plate<br>0.75<br>40<br>=<br>=<br>on                     | E in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>Pt=<br>A <sub>e</sub> =<br>=<br>A <sub>g</sub> =<br>=                               | n<br>cm<br>KN<br>φ* F <sub>v</sub> *A <sub>t</sub><br>P <sub>t</sub> /(φ* F<br>0.5<br>A <sub>e</sub> +(d+.1<br>1.31  | cm <sup>2</sup><br>.5)*t<br>cm <sup>2</sup>                    |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi<br>Gross Area<br>Length in ter                                 | e plate<br>0.75<br>40<br>=<br>=<br>on                     | E in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>Pt=<br>Ae=<br>=<br>Ag=<br>=<br>Lt=<br>-   | n<br>cm<br>cm<br>KN<br>$\phi^* F_v^* A_v^*$<br>$P_t/(\phi^* F_v^* A_v^*)$<br>$A_e^+(d+.1)$<br>1.31<br>$A_g/t$<br>2.18  | cm <sup>2</sup><br>.5)*t<br>cm <sup>2</sup>                    |            |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi<br>Gross Area<br>Length in ter                                 | e plate<br>0.75<br>40<br>=<br>=<br>on<br>nsion            | E in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>Pt=<br>A <sub>e</sub> =<br>=<br>A <sub>g</sub> =<br>=<br>L <sub>t</sub> =<br>=<br>= | n<br>cm<br>cm<br>KN<br>$\phi^* F_v^* A_d$<br>$P_t/(\phi^* F_v^* A_d)$<br>$P_t/(\phi^* F_v^* A_d)$<br>$A_e^+(d+.1)$<br>1.31<br>$A_g/t$<br>2.18<br>1.5*d           | cm <sup>2</sup><br>.5)*t<br>cm <sup>2</sup><br>cm <sup>2</sup> |            |
| Design of th<br>φ=<br>F <sub>u</sub> =<br>Thickeness t:<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi<br>Gross Area<br>Length in ter<br>Edge distanc              | e plate<br>0.75<br>40<br>=<br>on<br>nsion<br>e of th      | e in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>Pt=<br>Ae=<br>=<br>Ag=<br>=<br>Lt=<br>=<br>e pin=<br>-                              | n<br>cm<br>cm<br>KN<br>$\phi^* F_v^* A_0$<br>$P_t/(\phi^* F_v^* A_0)$<br>$P_t/(\phi^* F_v^* A_0)$<br>$A_e^+(d+.1)$<br>1.31<br>$A_g/t$<br>2.18<br>$1.5^*d$<br>1.8 | cm <sup>2</sup><br>.5)*t<br>cm <sup>2</sup><br>cm              | use 1.9 cm |
| Design of th<br>$\phi$ =<br>$F_u$ =<br>Thickeness t=<br>Dia of pin d=<br>Tension load<br>Tension load<br>Area in tensi<br>Gross Area<br>Length in ter<br>Edge distanc<br>Edge distanc | e plate<br>0.75<br>40<br>=<br>=<br>on<br>nsion<br>e of th | e in tension<br>KN/cm <sup>2</sup><br>0.6<br>1.2<br>15<br>Pt=<br>Ae=<br>=<br>Ag=<br>=<br>Lt=<br>=<br>e pin=<br>=<br>oth side=                 | n<br>cm<br>cm<br>KN<br>$\phi^* F_v^* A_0$<br>$P_t/(\phi^* F_v^* A_1)$<br>$A_e^+(d+.1)$<br>1.31<br>$A_g/t$<br>2.18<br>$1.5^*d$<br>1.8                             | cm <sup>2</sup><br>.5)*t<br>cm <sup>2</sup><br>cm<br>cm<br>3.6 | use 1.9 cm |

OK



#### Design of bolts in clamping plate

| $R_b = \phi^* F_v^*$ | Av                |                         |                    |            |                 |                                      |
|----------------------|-------------------|-------------------------|--------------------|------------|-----------------|--------------------------------------|
| Assume 3 bolts       |                   |                         |                    |            |                 |                                      |
| Load on bolts=       | wxl               |                         |                    | 0.9        | KN              |                                      |
| Load on each b       | olts=             |                         |                    | 0.30       | KN              |                                      |
| Then                 |                   |                         | 2                  |            |                 |                                      |
| A <sub>v</sub> =     |                   | 0.02                    | cm²                |            |                 |                                      |
| Required dia d=      | =                 | 0.18                    | cm                 |            |                 |                                      |
| use 5mm bolts        |                   |                         |                    |            |                 |                                      |
| Design of weld       | on arm            | าร                      | Fillet             | type w     | eld             |                                      |
| φ=                   | 0.75              |                         |                    |            |                 |                                      |
| F <sub>E60</sub> =   | 42                | KN/cm <sup>2</sup>      |                    |            |                 |                                      |
| $F_{w} = 0.6*F_{E}$  | 60                |                         |                    |            |                 |                                      |
| Design strength      | n per cn          | n for .3cm o            | of weld            | <b>1</b> = |                 | 0.75*0.6*F <sub>E60</sub> *0.707*0.3 |
|                      |                   |                         |                    |            | =               | 4.0 KN/cm                            |
| Load on weld=        |                   | 12.3                    | KN                 |            |                 |                                      |
| No. of weld=         |                   | 2                       |                    |            |                 |                                      |
| Load per weld=       |                   | 6.15                    | KN                 |            |                 |                                      |
| Required weld        | length=           | :                       |                    | 1.53       | cm              |                                      |
| use 3cm weld         |                   |                         |                    |            |                 |                                      |
| Design of the t      | ube for           | edge cable              | 9                  |            |                 |                                      |
| Load=                | 12.3              | KN                      |                    |            |                 |                                      |
| F <sub>v</sub> =     | 24.5              | KN/cm <sup>2</sup>      |                    |            |                 |                                      |
| Area required t      | o resist          | : A=                    |                    | 0.50       | cm <sup>2</sup> |                                      |
| Inner dia of the     | tube f            | or cable en             | d PEO3             | is         |                 | 1.2 cm                               |
| Then, outer are      | a- inne           | r area= 0.4             | 8                  |            | cm <sup>2</sup> |                                      |
| Thickness t=         |                   | 0.24                    | cm                 |            |                 |                                      |
| use 0.35cm thic      | ck tube           |                         |                    |            |                 |                                      |
| Design of the n      | in in de          | uublo shoar             |                    |            |                 |                                      |
| d=                   | 0.75              |                         |                    |            |                 |                                      |
| $\Psi^{-}$           | 0.75              | 2                       | ultim              | ate        |                 |                                      |
| F <sub>u</sub> =     | 40                | KN/cm <sup>2</sup>      | stren              | gth        |                 |                                      |
| Area in shear        | -                 | A <sub>sf</sub>         |                    | 0-         |                 |                                      |
| Design load          |                   | P <sub>d</sub> =        | φ*0.6              | 5* F.,* A  | A <sub>sf</sub> |                                      |
| Design load          |                   | 12                      | KN                 |            |                 |                                      |
| Then                 | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6 | * F <sub>u</sub> ) |            |                 |                                      |
|                      | =                 | 0.67                    | cm <sup>2</sup>    |            |                 |                                      |
| Area of the pin      | =                 | 0.33                    | cm <sup>2</sup>    |            |                 |                                      |
| Dia of the pin d     | =                 | 0.65                    | cm                 |            |                 |                                      |
| use .9cm pin         |                   | PE 3                    |                    |            |                 |                                      |
| Design of the m      | in in h           | aring                   |                    |            |                 |                                      |
| d-                   | 0.75              | anng                    |                    |            |                 |                                      |
| Ψ-                   | 0.75              | 2                       | ultim              | ate        |                 |                                      |
| F <sub>y</sub> =     | 24 5              | KN/cm <sup>2</sup>      | stren              | gth        |                 |                                      |
| Area in shear        | 21.5              | d⊾*t                    | Streng             | 5          |                 |                                      |
| Design load          |                   | P <sub>d</sub> =        | <b>ሐ</b> *1.8      | 3* F.,* d  | և*t             |                                      |
| Design load          |                   | 12                      | KN                 | y y        | .0.             |                                      |
| d <sub>b</sub> =     | 1.05              | cm                      |                    |            |                 |                                      |
| Thickness t=         |                   | 0.35                    | cm                 |            |                 |                                      |
| use 0.6cm thick      | plate             |                         |                    |            |                 |                                      |
| Docian of the        |                   | toncion                 |                    |            |                 |                                      |
|                      |                   | tension                 |                    |            |                 |                                      |
| Ψ-<br>F -            | 0.75<br>//        | KN/cm <sup>2</sup>      |                    |            |                 |                                      |
| Thickeness t-        | 40                |                         | cm                 |            |                 |                                      |
| Dia of nin d=        |                   | 0.0<br>N Q              | cm                 |            |                 |                                      |
|                      |                   | 0.9                     | 0111               |            |                 |                                      |
| lension load =       |                   | 12                      | KN                 |            |                 |                                      |

|                             | =                |                   | 1.03 | cm <sup>2</sup> |           |
|-----------------------------|------------------|-------------------|------|-----------------|-----------|
| Length in tension           | L <sub>t</sub> = | A <sub>g</sub> /t |      |                 |           |
|                             | =                |                   | 1.72 | cm              |           |
| Edge distance of the pin=   |                  | 1.5*d             |      |                 |           |
|                             | =                | 1.35              |      | cm              | use 1.5cm |
| Edge distance on both side= |                  |                   | 2.7  | cm              |           |
|                             |                  |                   | 2.7  | >               | 1.72      |

ОК

| $ \begin{array}{c} \begin{array}{c} \begin{array}{c} \begin{array}{c} \underline{\text{Design of the Corner Plate CP03} \\ \hline \\ \hline \\ \hline \\ \hline \\ \text{Here size} \\ \hline \\ $   |     |                            |                                    |                    |              |                 |                |                                      |              | $\Lambda_{1}$ |              |              |
|--|-----|----------------------------|------------------------------------|--------------------|--------------|-----------------|----------------|--------------------------------------|--------------|---------------|--------------|--------------|
| Telesing of the Corner Plate 5003Plate siteHere $F_{re}$ 2.4.5M. =2.5.71.51.62.5.8M. =2.5.8M. =2.5.9N. CmMay =M. =2.5.9N. CmMay =M. =2.5.9N. CmMay =M. =2.5.9N. CmMay =2.5.9N. Cm2.5.92.5.9N. Cm2.5.92.62.7.9<  |     |                            |                                    |                    |              |                 |                | $\langle \rangle$                    |              |               |              | / ,          |
| Plete size<br>Here         Fr         24.5         KN/cm <sup>2</sup> For A36 steel $\phi_{h}^{2}$ 0.75         1         18.6         cm $w = 0.06$ KN/cm         for fabric         19 $h^{2}$ 0.05         KN/cm         for fabric $h^{2}$ 12.8         KN         for edge cables $h^{2}$ FV/d         K         10 $h^{2}$ FV/d         10         10 $h^{2}$ FV/d         10         10 $h^{2}$ KVr,f         cm <sup>2</sup> 10 $h^{2}$ 2.38         cm <sup>2</sup> 10         11 $h^{2}$ 2.38         cm <sup>2</sup> 10         10         10 $h^{2}$ 4.2         cm         10   |     | Design                     | of the Corne                       | er Plate CP        | 03           |                 |                | -                                    |              |               |              |              |
| Here<br>Free<br>$P_{e}$ 24.5 KN/cm <sup>3</sup> For A36 steel<br>$0^{h}_{e}$ 0.75<br>$P_{e}$ 12 KN for for fobric<br>$P_{e}$ 12 KN for degreables<br>$M_{e}$ w//8<br>= 25.9 KN cm<br>$M_{e}$ P//4<br>= 55.80 KN-cm<br>$Z_{e}$ 55.80 KN/cm<br>$Z_{e}$ 5  |     | Plate si                   | ze                                 |                    |              |                 |                |                                      |              |               |              |              |
| $ \begin{array}{rcl} F_{\mu}^{2} & 2.4.5 & \text{KN/cm} & \text{For AB steel} \\ \phi_{\mu}^{2} & 0.75 & \text{cm} \\ \text{is} & 18.6 & \text{cm} \\ \text{w} & 0.06 & \text{KN/cm} & \text{for fabric} \\ \text{p} & 12 & \text{KN} & \text{for clapsc cables} \\ \text{m} & \text{w/VB} & \text{ss.} \\ \text{ss.} & 2.53 & \text{KN-cm} \\ \text{M} & \text{w/VB} & \text{ss.} \\ \text{ss.} & 2.53 & \text{KN-cm} \\ \text{M} & \text{w/VA} & \text{ss.} \\ \text{ss.} & 3.33 & \text{KN-cm} \\ \text{m} & \text{M} & \text{M} & \text{M} \\ \text{ss.} & 10^{2} & \text{ss.} \\ \text{2.33 & \text{cm}^{3}} \\ \text{2.34 & \text{cm}^{3}} \\ \text{2.35 & \text{cm}^{3}} \\ 2.35 & \text{$ |     | Here                       |                                    |                    | _            |                 |                |                                      |              | V             |              |              |
|  |     | F <sub>y</sub> =           | 24.5                               | KN/cm <sup>2</sup> | For <i>I</i> | A36 ste         | el             |                                      |              |               |              |              |
| $ \begin{array}{rrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrrr$  |     | Φ <sub>b</sub> =           | 0.75                               |                    |              |                 |                |                                      |              |               |              |              |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$  |     | =                          | 18.6                               | cm                 |              |                 |                |                                      | $\backslash$ |               |              |              |
| M = w/12  KN  cm  for edge cables  M = w/12  KN  cm  for edge cables  M = w/14  for edge cab  |     | W=                         | 0.06                               | KN/CM              | tor t        | abric           | <b>b l a a</b> |                                      | $\backslash$ |               |              |              |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$  |     | P=                         | 12                                 | KN                 | for e        | edge ca         | bles           |                                      |              |               | /            |              |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$  |     | $M_1 =$                    | WF/8                               |                    |              |                 |                |                                      |              |               | $\sim$       |              |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$  |     | =                          | 2.59                               | KN-cm              |              |                 |                | 4 Ø5mm A307 BOLT                     |              | 186           | / 】          |              |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  |     | $IVI_2 =$                  | PI/4                               |                    |              |                 |                |                                      |              | 150           |              |              |
|  |     | =                          | 55.80                              | KN-CM              |              |                 |                |                                      |              | 150 —         |              |              |
| $ \begin{array}{c} z = 58.39 \\ z = 50^{17}/6 \\ z = 50^{17$  |     | 1/1=                       | IVI <sub>1</sub> +IVI <sub>2</sub> |                    |              |                 |                |                                      |              | 200 0         |              |              |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  |     | =                          | 58.39                              | KN-CM              |              |                 |                | DE2 000                              |              | 60 11         |              |              |
| 2.36 Cm<br>2.5 b <sup>2</sup> /5<br>Assume thichness of the plate 6mm<br>b = 0.6 cm<br>hen h = 4.88 cm Use 6cm Plate<br><b>Clamping plate size</b><br>F, = 2.45 KN/cm <sup>2</sup><br>I = 4.2 cm<br>w = 0.06 KN/cm<br>M <sub>s</sub> = w <sup>2</sup> /8<br>0.13 KN-cm<br>Z = M <sub>s</sub> /F <sub>s</sub><br>0.0054 cm <sup>3</sup><br>Z = b <sup>1</sup> /5<br>Assume thichness of the plate 3mm<br>b = 0.3 cm<br>use 2 cm plate<br><b>Design of bolts in clamping plate</b><br>$\phi$ = 0.75<br>F, = 16.5 KN/cm <sup>3</sup> For A307 bolts<br>w = 0.06 KN/cm<br>I = 15.8 cm<br>R <sub>a</sub> = $\phi$ * F,*A,<br>Assume 3 bolts<br>Load on bolts=<br>wid<br>0.18 cm<br>use 5 mm bolts<br><b>Design of weld on arms</b><br>Fillet type weld<br>$\phi$ = 0.75<br>F <sub>max</sub> <sup>-</sup> 42 KN/cm <sup>3</sup><br>F <sub>max</sub> <sup>-</sup> 42 KN/cm <sup>3</sup><br>I = 0.03 cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use 5 mm bolts<br><b>Design of weld on arms</b><br>Fillet type weld<br>$\phi$ = 0.75°0.6*F <sub>max</sub> °0.707°0.3<br>= 4.0 KN/cm<br>Load on weld= 6 KN<br>No, of weld= 2<br>Load one weld= 5 KN<br>Required weld length= 0.75 cm<br>we weld  |     | Z=                         |                                    |                    |              |                 |                | PE3 989                              | 30           |               | 30           | PE3 989      |
| Assume thichness of the plate 6mm<br>b = 0.6 cm<br>h = 4.88 cm Use 6cm Plate<br>Clamping plate size<br>$F_{\pi^{2}} = 24.5 \text{ KN/cm}^{2}$<br>I = 4.2  cm<br>w = 0.06  KN/cm<br>$M_{\pi^{2}} wi^{2}/8$<br>0.13 KN-cm<br>$Z = M_{\pi}/F_{\pi}$<br>0.0054 cm <sup>3</sup><br>$Z = bh^{2}/6$<br>Assume thichness of the plate 3mm<br>b = 0.3  cm<br>use 2  cm plate<br>Design of bolts in clamping plate<br>$\phi = 0.75$<br>$F_{\pi^{2}} = 1.65 \text{ KN/cm}^{3}$ For A307 bolts<br>w = 0.06  KKV/cm<br>I = 15.8  cm<br>$R_{\pi^{2}} \phi^{+} F_{\pi}^{+} A_{\pi}$<br>Assume 3 bolts<br>Load on bolts=<br>wxl<br>$A_{\pi} = 0.03 \text{ cm}^{2}$<br>Required dia $d = 0.18 \text{ cm}$<br>use 5  cm  fillet type weld<br>$\phi = 0.75$<br>$F_{\pi^{2}} = 0.67 \text{ from}$<br>Design strength per cm for .3cm of weld = 0.75*0.6* F_{\pi\pi^{0}} 0.707*0.3<br>= 4.0  KN/cm<br>Load on weld = 6 KN<br>No. of weld = 2<br>Load on weld = 6 KN<br>No. of weld = 2<br>Load per weld = 3 KN<br>Required weld length= 0.75 cm<br>we will  |     | -                          | 2.38                               | cm                 |              |                 |                |                                      | 19           | <u> </u>      | 19           | 1            |
| be 0.6 cm<br>hen h= 4.88 cm Use 6cm Plate<br>Clamping plate size<br>$F_{r} = 24.5 \text{ KM/cm}^2$<br>I = 4.2 cm<br>w = 0.06  KM/cm<br>$M_{\pi} = wl^2/8$<br>0.13  KN-cm<br>$2 = M_{\pi}F_{r}$<br>$0.0054 \text{ cm}^3$<br>$2 = bh^2/6$<br>Assume thichness of the plate 3mm<br>be 0.3 cm<br>b = 0.3  cm<br>b = 0.33  cm<br>use 2  cm plate<br><b>Design of bolts in clamping plate</b><br>$\varphi = 0.75$<br>$F_{\pi} = 16.5 \text{ KM/cm}^2$ For A307 bolts<br>w = 0.06  KM/cm<br>I = 15.8  cm<br>$R_{g} = \varphi^+ \Gamma_{\pi}^+ A_{\Lambda}$<br>Assume 3 bolts<br>Load on bolts = 0.32 KN<br>Then<br>$A_{\pi} = 0.03 \text{ cm}^2$<br>Required id a = 0.18  cm<br>use 5  sm bolts<br><b>Design fined on arms</b> Fillet type weld<br>$\varphi = 0.75^{+}F_{ma}^{-} 0.32 \text{ KN}$<br>Then<br>$A_{\pi} = 0.03 \text{ cm}^2$<br>Required id a = 0.18  cm<br>use 5  sm bolts<br><b>Design strength</b> per cm for .3cm of weld= 0.75^{+}F_{ma}^{+}0.707^{+}0.3<br>= 4.0  KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 \text{ cm}   |     | Z=                         | DN /6                              | fthe plate         | C 1999 1999  |                 |                | 30mm E60 WELD                        | $\bigvee$    |               |              | 30mm E60 WE  |
| here here here here here here here here  |     | Assume                     |                                    | or the plate       | 6000         |                 |                |                                      | 7            |               |              | $\mathbf{N}$ |
| The interval of the interval   | han | D=                         | 0.0                                | cm                 |              |                 | <b>a</b> ta    | V                                    |              | N             |              |              |
| Clamping plate size<br>$F_{r}^{=} 24.5 \text{ KN/cm}^{2}$<br>I = 4.2  cm<br>w = 0.06  KN/cm<br>$M_{e} = w^{1}/8$<br>0.13  KN-cm<br>$Z = M_{e}/F_{e}$<br>$0.0054 \text{ cm}^{3}$<br>$Z = bh^{1}/6$<br>Assume thichness of the plate 3mm<br>b = 0.3  cm<br>b = 0.3  cm<br>use 2  cm plate<br>Design of bolts in clamping plate<br>$\phi = 0.75$<br>$F_{e} = 16.5 \text{ KN/cm}^{2}$ For A307 bolts<br>w = 0.06  KN/cm<br>I = 15.8  cm<br>$R_{e} \phi^{+} F_{e}^{*}A_{e}$<br>Assume 5 bolts<br>Load on bolts=<br>0.32  KN<br>Then<br>$A_{e} = 0.03 \text{ cm}^{2}$<br>Required dia $d = 0.18 \text{ cm}$<br>use 5  cm bolts<br>Design of weld on ams<br>Fillet type weld<br>$\phi = 0.75^{\circ} 0.6^{\circ} F_{E00}^{\circ} 0.707^{\circ} 0.3$<br>$F_{e0}^{\circ} = 42 \text{ KN/cm}^{2}$<br>$F_{e0}^{\circ} = 42 \text{ KN/cm}^{2}$<br>$F_{e0}^{\circ} = 0.75^{\circ} F_{E00}^{\circ} 0.707^{\circ} 0.3$<br>Load on weld = 6  KN<br>No. of weld = 2<br>Load on weld = 6 KN<br>No. of weld = 3 KN<br>Required weld length = 0.75 \text{ cm}  | nen | n=                         | 4.88                               | CIII               | Use          | OCIII PI        | ale            |                                      |              | $\bowtie$     | <            |              |
| $F_{r} = 24.5 \text{ KN/cm}^{2}$ $I = 4.2 \text{ cm}$ $W = 0.06 \text{ KN/cm}$ $M_{n} = wF/8$ $0.13 \text{ KN-m}$ $Z = M_{n}/F_{r}$ $0.032 \text{ cm}^{3}$ $Z = bh'/6$ Assume thichness of the plate 3mm<br>b= 0.33 \text{ cm} $Use 2 \text{ cm plate}$ $Design of bolts in clamping plate \varphi = 0.75 F_{r} = 16.5 \text{ KN/cm}^{2} \text{ For A307 bolts} W = 0.06 \text{ KN/cm} I = 15.8 \text{ cm} R_{e} = \varphi^{4} F_{r} A_{e} Assume 3 boltsLoad on bolts=Wal 0.9 \text{ KN} Load on each bolts = 0.32 \text{ KN} Then A_{r} = 0.03 \text{ cm}^{2} Required dia d = 0.18 \text{ cm} Use 5 \text{ rm bolts} Design of weld on arms \qquad Fillet type weld \varphi = 0.75^{4} F_{E00}^{4} 0.75^{7} F_{E00}^{2} 0.75^{4} 0.75^{4} 0.70^{4} 0.3 I = 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.75^{4} 0.75^{4} 0.70^{4} 0.3 I = 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.70^{4} 0.3 I = 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.70^{4} 0.3 I = 0.75^{4} 0.5^{4} F_{E00} 0.75^{4} 0.5^{4} F_{E0} 0.5^{4} F_{E0} 0.5^{4} 0.5^{4} F_{E0} 0.5^{4} $   |     | Clampi                     | ng plate size                      | 2                  |              |                 |                |                                      |              |               | $\mathbf{i}$ |              |
| $ \begin{array}{cccccccccccccccccccccccccccccccccccc$  |     | F <sub>y</sub> =           | 24.5                               | KN/cm <sup>2</sup> |              |                 |                |                                      |              |               | PE3 98       | 31           |
| $w = 0.06 \text{ KN/cm}$ $M_{a} = wi^{2}/8$ $0.13 \text{ KN-cm}$ $Z = M_{a}/F_{a}$ $0.0054 \text{ cm}^{3}$ $Z = bh^{2}/6$ Assume thichness of the plate 3mm $b = 0.3 \text{ cm}$ $b = 0.75 \text{ fr}_{c} = 1.65 \text{ KN/cm}^{2} \text{ For A307 bolts}$ $w = 0.06 \text{ KN/cm}$ $b = 0.32 \text{ cm}$ $R_{a} = \phi^{a} \text{ F}_{a}^{*} \text{ A}_{a}$ Assume 3 bolts<br>Load on bolts = 0.32 \text{ KN} Then $A_{c} = 0.03 \text{ cm}^{2}$ Required dia d = 0.18 cm<br>use Smm bolts $Design of weld on arms \qquad Fillet type weld$ $\phi = 0.75 \text{ fr}_{cm} = 0.75 \text{ Freco}^{+}0.707^{+}0.3$ $e = 0.75^{+}6.6^{+}F_{coo}^{+}0.707^{+}0.3$ $E = 0.75^{+}6.6^{+}6.6^{-}0.707^{+}0.3$ $E = 0.75^{+}6.6^{+}6.6^{-}0.707^{+}0.3$ $E = 0.75^{+}6.6^{-}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{+}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}6.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}0.707^{+}0.3$ $E = 0.75^{-}0.6^{-}0.75^{-}0.6^{-}0.707^$   |     | I=                         | 4.2                                | cm                 |              |                 |                |                                      |              |               |              |              |
| $M_{n} = wl^{2}/8$ $0.13 \text{ KN-cm}$ $Z = M_{n}/F_{n}$ $0.0054 \text{ cm}^{3}$ $Z = bh^{2}/6$ Assume thichness of the plate 3mm<br>b = 0.3 cm<br>use 2 cm plate<br><b>Design of bolts in clamping plate</b><br>$\Phi^{\pm} = 0.75$<br>$F_{r} = 16.5 \text{ KN/cm}^{2}$ For A307 bolts<br>w = 0.06 KN/cm<br>i = 15.8 cm<br>$R_{q} = \Phi^{*}F_{r}^{*}A_{q}$<br>Assume 3 bolts<br>Load on bolts=<br>wxl 0.9 KN<br>Load on each<br>bolts=<br>0.32 KN<br>Then<br>$A_{r} = 0.03 \text{ cm}^{2}$<br>Required dia d = 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\Phi^{\pm} = 0.75$<br>$F_{wc} = 0.6^{*}F_{tco}$<br>Design strength per cm for .3cm of weld = 0.75^{*}0.6^{*}F_{tco}^{*}0.707^{*}0.3<br>= 4.0  KN/cm<br>Load on weld = 6 KN<br>No. of weld = 2<br>Load per weld = 3 KN   |     | w=                         | 0.06                               | KN/cm              |              |                 |                |                                      |              | Щ             |              |              |
| $Z = M_{v}/F_{v}$ $0.0054 cm^{3}$ $Z = bh^{3}/6$ Assume thichness of the plate 3mm $b = 0.3 cm$ $b = 0.3 cm$ $use 2 cm plate$ $Design of bots in clamping plate \Phi^{=} 0.75 F_{v} = 1.65 KN/cm^{2} For A307 bolts w = 0.06 KN/cm l = 15.8 cm R_{0} = \Phi^{+}F_{v}A_{v} Assume 3 bolts Load on bolts = wkl 	0.9 KN Load on each bolts = 0.32 KN Then A_{v} = 0.03 cm^{2} Required dia d = 0.18 cm use 5mm bolts Fillet type weld \Phi^{=} 0.75 F_{rea0} = 42 KN/cm^{2} F_{w} = 0.6^{+}F_{rea0} Design strength per cm for 3cm of weld = 0.75^{+}0.6^{+}F_{rea0}^{+}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{+}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{+}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{+}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{-}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{-}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{-}0.6^{+}F_{rea0}^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{-}0.6^{+}F_{rea0}^{-}0.75^{-}0.75^{-}0.707^{+}0.3 Eosign strength per cm for 3cm of weld = 0.75^{-}0.7$   |     | M <sub>n</sub> =           | wl <sup>2</sup> /8                 | KN-cm              |              |                 |                |                                      |              |               |              |              |
| $ \begin{array}{c} 0.0054 \ \text{cm}^3 \\ Z = \ bh^3/6 \\ \text{Assume thichness of the plate 3mm} \\ b = \ 0.3 \ \text{cm} \\ b = \ 0.3 \ \text{cm} \\ b = \ 0.3 \ \text{cm} \\ \text{is 2 cm plate} \\ \hline \begin{array}{c} \textbf{Design of bolts in clamping plate} \\ \phi = \ 0.75 \\ F_{v} = \ 16.5 \ \text{KN/cm}^2 \ \text{ For A307 bolts} \\ w = \ 0.06 \ \text{KN/cm} \\ i = \ 15.8 \ \text{cm} \\ \text{Res } \phi^* F_{v}^* A_v \\ \text{Assume 3 bolts} \\ \text{Load on bolts} \\ \text{wxl} \\ \text{O.9 \ KN} \\ \text{Load on bolts} \\ \text{wxl} \\ \text{od on bolts} \\ \text{bolts} \\ \text{od on bolts} \\ \text{use 5rm bolts} \\ \hline \begin{array}{c} \textbf{Design of well on arms} \\ \text{Fillet type welld} \\ \phi = \ 0.75 \\ F_{rso} = \ 4.2 \ \text{KN/cm}^2 \\ F_{rso} = \ 4.2 \ \text{KN/cm} \\ \text{Design strength per cm for .3cm of welle} \\ \hline \begin{array}{c} 0.75^*0.6^*F_{F60}^*0.707^*0.3 \\ = \ 4.0 \ \text{KN/cm} \\ \text{No. of welle} \\ 2 \\ \text{Load on weld} \\ \text{Required well length} = \ 0.75 \ \text{cm} \\ \text{Required well length} = \ 0.75 \ \text{cm} \\ \end{array}$   |     | Z=                         | M <sub>n</sub> /F <sub>v</sub>     |                    |              |                 |                |                                      |              |               |              |              |
| $Z = bh^{2}/6$ Assume thichness of the plate 3mm<br>b = 0.3 cm<br>hen h = 0.33 cm<br>use 2 cm plate<br>$ \begin{array}{rcl} Design of bots in clamping plate                                     $   |     |                            | 0.0054                             | cm <sup>3</sup>    |              |                 |                |                                      |              |               |              |              |
| Assume thickness of the plate 3mm<br>b = 0.3 cm<br>b = 0.3 cm<br>use 2 cm plat=<br>Pesign of bolts in clamping plate<br>$\varphi = 0.75$<br>$F_{v} = 16.5$ KN/cm <sup>2</sup> For A307 bolts<br>w = 0.06 KN/cm<br>I = 15.8 cm<br>$R_{0} = \varphi + F_{v} A_{v}$<br>Assume 3 bolts<br>Load on bolts=<br>wxl 0.9 KN<br>Load on bolts=<br>wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_{v} = 0.03$ cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use 5mm bolts<br>Pesign of weld on arms Fillet type weld<br>$\varphi = 0.75 - F_{reco} 42$ KN/cm <sup>2</sup><br>$F_{v} = 0.6^{+}F_{reco}$<br>Design strength per cm for .3cm of weld = 0.75*0.6*F_{reco}*0.707*0.3<br>= 4.0 KN/cm  |     | Z=                         | bh²/6                              |                    |              |                 |                |                                      |              |               |              |              |
| b = 0.3 cm<br>hen h = 0.33 cm<br>use 2 cm plate<br>$\varphi = 0.75$<br>$F_v = 16.5 KN/cm^2$ For A307 bolts<br>w = 0.06 KN/cm<br>H = 15.8 cm<br>$R_0 = \varphi * F_v * A_v$<br>Assume 3 bolts<br>Load on bolts = 0.32 KN<br>Load on each<br>bolts = 0.32 KN<br>Then<br>$A_v = 0.03 cm^2$<br>Required dia d = 0.18 cm<br>use 5mm bolts<br>Design of weld on arms Fillet type weld<br>$\varphi = 0.75$<br>$F_{te0} = 42 KN/cm^2$<br>$F_{va} = 0.6^*F_{reo}$<br>Design strength per cm for .3cm of weld = 0.75*0.6*F_{reo}*0.707*0.3<br>= 4.0 KN/cm  |     | Assume                     | e thichness c                      | of the plate       | 3mm          |                 |                |                                      |              |               |              |              |
| hen h= 0.33 cm<br>use 2 cm plate<br>Design of bolts in clamping plate<br>$\phi = 0.75$<br>F,= 16.5 KN/cm <sup>2</sup> For A307 bolts<br>w= 0.06 KN/cm<br>I= 15.8 cm<br>R,= $\phi^{+}$ F,*A,<br>Assume 3 bolts<br>Load on bolts=<br>wal 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>A,= 0.03 cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use 5mm bolts<br>Design of weld on arms Fillet type weld<br>$\phi = 0.75$<br>F <sub>600</sub> 42 KN/cm <sup>2</sup><br>F <sub>600</sub> 542 KN/cm <sup>2</sup><br>F <sub>600</sub> 642 KN/cm <sup>2</sup><br>F <sub>600</sub> 50 CT5 <sup>4</sup> C.5 <sup>4</sup> F <sub>600</sub> <sup>40</sup> C.75 <sup>40</sup> C.75 <sup>40</sup> C.75 <sup>40</sup> C.707 <sup>40</sup> C.3<br>= 4.0 KN/cm  |     | b=                         | 0.3                                | cm .               |              |                 |                |                                      |              |               |              |              |
| use 2 cm plate<br>Design of bolts in clamping plate<br>$\varphi = 0.75$<br>$F_{r} = 16.5$ KN/cm <sup>2</sup> For A307 bolts<br>w = 0.06 KN/cm<br>l = 15.8 cm<br>$R_{r} = \varphi * F_{r}^{*} A_{r}$<br>Assume 3 bolts<br>Load on bolts<br>wxl 0.9 KN<br>Load on bolts<br>wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_{r} = 0.03$ cm <sup>2</sup><br>Required dia d = 0.18 cm<br>use Smm bolts<br>Design of weld on arms Fillet type weld<br>$\varphi = 0.75$<br>$F_{too} = 42$ KN/cm <sup>2</sup><br>$F_{w} = 0.6^{*} F_{to0}$<br>Design strength per cm for .3cm of weld = 0.75*0.6* F_{to0}*0.707*0.3<br>= 4.0 KN/cm<br>Load on weld = 6 KN<br>No. of weld = 2<br>Load op r weld = 3 KN<br>Required weld length = 0.75 cm<br>we 3 m weld  | hen | h=                         | 0.33                               | cm                 |              |                 |                |                                      |              |               |              |              |
| Design of bolts in clamping plate $\phi = 0.75$ $F_{r} = 16.5 \text{ KM/cm}^2$ for A307 bolts $w = 0.06 \text{ KN/cm}$ for A307 bolts $w = 0.06 \text{ KN/cm}$ for A307 bolts $u = 15.8 \text{ cm}$ $R_{0} = \phi^{2} \text{ F}_{v} \text{ A}_{v}$ Assume 3 boltsLoad on bolts=wxl0.9 KNLoad on each0.32 KNbolts=0.32 cm²Required dia d=0.18 cmuse 5mm boltsscm²Fress= 42 KN/cm² $F_{co0} = 0.75$ $F_{co0} = 0.6^{\circ} F_{co0}$ Design of weld on armsFillet type weld $\phi = 0.75$ $6.6^{\circ} F_{co0}^{\circ} 0.707^{\circ} 0.3$ $= 4.0 \text{ KN/cm}$ Load on weld=6 KNNo. of weld=2Load on weld=3 KNRequired weld length=0.75 cmwe ad m weld0.75 cm  |     | use 2 ci                   | m plate                            |                    |              |                 |                |                                      |              |               |              |              |
| besign to bus in changing place<br>$\varphi = 0.75$<br>$F_v = 16.5 \text{ KN/cm}^2$ For A307 bolts<br>w = 0.06  KN/cm<br>l = 15.8  cm<br>$R_b = \varphi^* F_v^* A_v$<br>Assume 3 bolts<br>Load on bolts=<br>wxl 	0.9  KN<br>Load on bolts=<br>wxl 	0.9  KN<br>Load on each<br>bolts=	0.32 \text{ KN}<br>Then<br>$A_v = 0.03 \text{ cm}^2$<br>Required dia d = 0.18 cm<br>use 5mm bolts<br>Design of weld on arms Fillet type weld<br>$\varphi = 0.75$<br>$F_{E60} = 42 \text{ KN/cm}^2$<br>$F_w = 0.6^* F_{E60}$<br>Design strength per cm for .3cm of weld=	0.75*0.6* F_{E60}*0.707*0.3<br>= 4.0  KN/cm<br>Load on weld=	6 KN<br>No. of weld=	2<br>Load per weld=	3 KN<br>Required weld length=	0.75 cm<br>we a 3 cm weld   |     | Docign                     | of bolts in c                      | lamning nl         | ato          |                 |                |                                      |              |               |              |              |
| $ \begin{array}{llllllllllllllllllllllllllllllllllll$  |     | Design                     |                                    | iamping pi         | ale          |                 |                |                                      |              |               |              |              |
| $w = 0.06 \text{ KV/cm}$ $I = 15.8 \text{ cm}$ $R_{B} = \phi^{+} F_{*}^{*} A_{v}$ Assume 3 bolts Load on bolts= $wxl \qquad 0.9 \text{ KN}$ Load on each bolts= $0.32 \text{ KN}$ Then $A_{v} = 0.03 \text{ cm}^{2}$ Required dia d= $0.18 \text{ cm}$ use 5mm bolts $Design of weld on arms \qquad Fillet type weld$ $\phi = 0.75$ $F_{E60} = 42 \text{ KN/cm}^{2}$ $F_{w} = 0.6^{+}F_{E00}$ Design strength per cm for .3cm of weld= $0.75^{+}0.6^{+}F_{E60}^{+}0.707^{+}0.3$ $= 4.0 \text{ KN/cm}$ Load on weld= $6 \text{ KN}$ No. of weld= $2$ Load per weld= $3 \text{ KN}$ Required weld length= $0.75 \text{ cm}$  |     | Ψ-<br>⊑-                   | 16 5                               | KN/cm <sup>2</sup> | For          | A207 h          | olte           |                                      |              |               |              |              |
|  |     | г <sub>v</sub> -           | 10.5                               | KN/cm              | FUI          | A307 U          | ons            |                                      |              |               |              |              |
| $R_{b} = \Phi^{*} F_{v}^{*} A_{v}$ Assume 3 bolts<br>Load on bolts=<br>wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_{v} = 0.03 \text{ cm}^{2}$<br>Required dia d= 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\Phi = 0.75$<br>$F_{E60} = 42 \text{ KN/cm}^{2}$<br>$F_{w} = 0.6^{*} F_{E60}$<br>Design strength per cm for .3cm of weld= 0.75*0.6* $F_{E60}$ *0.707*0.3<br>= 4.0  KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>usa 5 cm weld   |     | - vv                       | 15.00                              | cm                 |              |                 |                |                                      |              |               |              |              |
| Assume 3 bolts<br>Load on bolts=<br>wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_v$ = 0.03 cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\phi$ = 0.75<br>$F_{E60}$ = 42 KN/cm <sup>2</sup><br>$F_w$ = 0.6*F <sub>E60</sub><br>Design strength per cm for .3cm of weld= 0.75*0.6*F <sub>E60</sub> *0.707*0.3<br>= 4.0 KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>usa 3 cm weld  |     | і—<br>Р. —                 | ۲٦.0<br>۳.۲ ۲                      | CIII               |              |                 |                |                                      |              |               |              |              |
| Load on bolts=<br>wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_v$ = 0.03 cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use Smm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\phi$ = 0.75<br>$F_{E60}$ = 42 KN/cm <sup>2</sup><br>$F_{w}$ = 0.6* $F_{E60}$<br>Design strength per cm for .3cm of weld= 0.75*0.6* $F_{E60}$ *0.707*0.3<br>= 4.0 KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>usa 3m weld  |     | ν <sub>b</sub> –           | $\Psi \Gamma_V A_V$                |                    |              |                 |                |                                      |              |               |              |              |
| wxl 0.9 KN<br>Load on each<br>bolts= 0.32 KN<br>Then<br>$A_v$ = 0.03 cm <sup>2</sup><br>Required dia d= 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\Phi$ = 0.75<br>$F_{E60}$ = 42 KN/cm <sup>2</sup><br>$F_w$ = 0.6* $F_{E60}$<br>Design strength per cm for .3cm of weld= 0.75*0.6* $F_{E60}$ *0.707*0.3<br>= 4.0 KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>use 3 cm weld  |     | Assume                     | bolte-                             |                    |              |                 |                |                                      |              |               |              |              |
| wki       0.3 KN         Load on each         bolts=       0.32 KN         Then $A_v$ =       0.03 cm <sup>2</sup> Required dia d=       0.18 cm         use 5mm bolts       0         Design of weld on arms       Fillet type weld $\phi$ =       0.75 $F_{E60}$ =       42 KN/cm <sup>2</sup> $F_w$ =       0.6*F <sub>E60</sub> Design strength per cm for .3cm of weld=       0.75*0.6*F <sub>E60</sub> *0.707*0.3 $=$ 4.0 KN/cm         Load on weld=       6 KN         No. of weld=       2         Load per weld=       3 KN         Required weld length=       0.75 cm         use 3cm weld       0.75 cm   |     |                            | 100113-                            |                    |              | 0 0             | KN             |                                      |              |               |              |              |
| bolts= 0.32 KN<br>Then<br>$A_v = 0.03 \text{ cm}^2$<br>Required dia d= 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\Phi = 0.75$<br>$F_{E60} = 42 \text{ KN/cm}^2$<br>$F_w = 0.6^*F_{E60}$<br>Design strength per cm for .3cm of weld= 0.75*0.6*F_{E60}*0.707*0.3<br>= 4.0  KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>use 3cm weld  |     |                            | n each                             |                    |              | 0.5             | KIN            |                                      |              |               |              |              |
| Then<br>$A_v = 0.03 \text{ cm}^2$<br>Required dia d= 0.18 cm<br>use 5mm bolts<br><b>Design of weld on arms</b> Fillet type weld<br>$\phi = 0.75$<br>$F_{E60} = 42 \text{ KN/cm}^2$<br>$F_w = 0.6^*F_{E60}$<br>Design strength per cm for .3cm of weld= 0.75*0.6*F_{E60}*0.707*0.3<br>= 4.0  KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>use 3cm weld  |     | bolts-                     | reach                              |                    |              | 032             | КN             |                                      |              |               |              |              |
| A <sub>v</sub> =0.03cm²Required dia d=0.18cmuse 5mm bolts <b>Design of weld on arms</b> Fillet type weld $\phi$ =0.75 $F_{E60}$ =42 KN/cm² $F_w$ =0.6*F <sub>E60</sub> Design strength per cm for .3cm of weld =0.75*0.6*F <sub>E60</sub> *0.707*0.3=4.0 KN/cmLoad on weld =66KNNo. of weld =2Load per weld =38KNRequired weld length =0.75 cmuse 3cm weld   |     | Thon                       |                                    |                    |              | 0.52            | KIN            |                                      |              |               |              |              |
| $V_{V}^{-}$ 0.03 cmRequired dia d=0.18 cmuse 5mm bolts <b>Design of weld on arms</b> Fillet type weld $\phi$ =0.75 $F_{E60}$ =42 KN/cm² $F_{w}$ =0.6*F <sub>E60</sub> Design strength per cm for .3cm of weld=0.75*0.6*F <sub>E60</sub> *0.707*0.3=4.0 KN/cmLoad on weld=6 KNNo. of weld=2Load per weld=3 KNRequired weld length=0.75 cmuse 3cm weld   |     | men                        | Δ =                                | 0 02               | $cm^2$       |                 |                |                                      |              |               |              |              |
| Required dia d0.18 cmuse 5mm boltsDesign of weld on armsFillet type weld $\phi = 0.75$ $F_{E60} = 42 \text{ KN/cm}^2$ $F_{w} = 0.6^*F_{E60}$ $F_{w} = 0.75^*0.6^*F_{E60}^*0.707^*0.3$ Design strength per cm for .3cm of weld = 0.75*0.6*F_{E60}*0.707*0.3 $= 4.0 \text{ KN/cm}$ Load on weld = 6 KNNo. of weld = 2Load per weld = 3 KNRequired weld length = 0.75 cmuse 3cm weld0.75 cm   |     | Poquire                    | Av-<br>- dia d-                    | 0.03               | cm           |                 |                |                                      |              |               |              |              |
| Design of weld on armsFillet type weld $\phi = 0.75$ $F_{E60} = 42 \text{ KN/cm}^2$ $F_{w} = 0.6^*F_{E60}$ $0.75^*0.6^*F_{E60}^*0.707^*0.3$ Design strength per cm for .3cm of weld = $0.75^*0.6^*F_{E60}^*0.707^*0.3$ $= 4.0 \text{ KN/cm}$ Load on weld = $6 \text{ KN}$ No. of weld = $2$ Load per weld = $3 \text{ KN}$ Required weld length = $0.75 \text{ cm}$   |     | use 5m                     | m bolts                            | 0.10               | CIII         |                 |                |                                      |              |               |              |              |
| besign of weid on arms Fillet type weid  |     | Design                     | of wold on a                       |                    | Filler       | + + 1 / 1 = - 1 | vold           |                                      |              |               |              |              |
| $\begin{array}{cccccccccccccccccccccccccccccccccccc$   |     | Design                     |                                    | 11115              | Fille        | t type v        | veiu           |                                      |              |               |              |              |
| $F_{w} = 0.6^{*}F_{E60}$ Design strength per cm for .3cm of weld= 0.75*0.6*F_{E60}*0.707*0.3<br>= 4.0 KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>use 3cm weld  |     | φ-                         | 12                                 | KN/cm <sup>2</sup> |              |                 |                |                                      |              |               |              |              |
| Design strength per cm for .3cm of weld= $0.75*0.6*F_{E60}*0.707*0.3$<br>= 4.0  KN/cm<br>Load on weld= $6 \text{ KN}$<br>No. of weld= $2$<br>Load per weld= $3 \text{ KN}$<br>Required weld length= $0.75 \text{ cm}$<br>use 3cm weld  |     | г <sub>Е60</sub> -         | 42<br>06*E                         | KN/CIII            |              |                 |                |                                      |              |               |              |              |
| = 4.0 KN/cm<br>Load on weld= 6 KN<br>No. of weld= 2<br>Load per weld= 3 KN<br>Required weld length= 0.75 cm<br>use 3 cm weld   |     | r <sub>w</sub> −<br>Design | strength per                       | cm for .3c         | m of v       | veld=           |                | 0.75*0.6*F <sub>E60</sub> *0.707*0.3 |              |               |              |              |
| Load on weid=     6     KN       No. of weld=     2       Load per weld=     3     KN       Required weld length=     0.75     cm  |     | 1                          |                                    | -                  | 1/8 1        |                 | =              | 4.0 KN/cm                            |              |               |              |              |
| No. of weige     2       Load per weld=     3 KN       Required weld length=     0.75 cm       use 3cm weld     0.75 cm  |     | Load or                    | 1 Weld=                            | 6                  | KN           |                 |                |                                      |              |               |              |              |
| Load per weid= 3 KN<br>Required weld length= 0.75 cm<br>use 3 cm weld  |     | INO. Of N                  | vela=                              | 2                  | 12.8.1       |                 |                |                                      |              |               |              |              |
| required weld leftglit= 0.75 cm  |     |                            | er weid=                           | 3<br>+h-           | KIN          |                 | 0.77           |                                      |              |               |              |              |
|  |     |                            | n weld                             | ui-                |              | 0.75            | CIII           |                                      |              |               |              |              |

**Design of the tube for edge cable** Load= 6 KN 24.5 KN/cm<sup>2</sup> F<sub>y</sub>= Area required to resist A= 0.24 cm<sup>2</sup> Inner dia of the tube for cable end PE03 is 1.2 cm Then, outer area- inner area= 0.48 cm<sup>2</sup> Thickness t= 0.12 cm use 0.35cm thick tube

#### Design of the pin in double shear

| φ=               | 0.75              |                         |   |
|------------------|-------------------|-------------------------|---|
| F <sub>u</sub> = | 40                | KN/cm <sup>2</sup>      | ultimate strength                       |
| Area in shear    |                   | $A_{sf}$                |   |
| Design load      |                   | P <sub>d</sub> =        | φ*0.6* F <sub>u</sub> * A <sub>sf</sub> |
| Design load      |                   | 12                      | KN                                      |
| Then             | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6 | 5* F <sub>u</sub> )                     |
|                  | =                 | 0.67                    | cm <sup>2</sup>                         |

| Area of the pin=<br>Dia of the pin d=<br>use .9cm pin | 0.33<br>0.65<br>PE 3 | cm <sup>2</sup><br>cm                 |
|---|----------------------|---------------------------------------|
| Design of the pin in                                  | bearing              |                                       |
| φ= 0.75   |                      |                                       |
| F <sub>y</sub> = 24.5                                 | KN/cm <sup>2</sup>   | ultimate strength                     |
| Area in shear   | d <sub>b</sub> *t    |                                       |
| Design load   | P <sub>d</sub> =     | $\phi^{*}1.8^{*}F_{y}^{*}d_{b}^{*}t$  |
| Design load   | 12                   | KN                                    |
| d <sub>b</sub> = 1.05                                 | cm                   |                                       |
| Thickness t=  | 0.35                 | cm                                    |
| use 0.6cm thick plat                                  | te                   |                                       |
| Design of the plate                                   | in tension           |                                       |
| φ= 0.75   |                      |                                       |
| F <sub>u</sub> = 40                                   | KN/cm <sup>2</sup>   |                                       |
| Thickeness t=   | 0.6                  | cm                                    |
| Dia of pin d=   | 0.9                  | cm                                    |
| Tension load =  | 12                   | KN                                    |
| Tension load  | P <sub>t</sub> =     | $\phi^* F_v^* A_e$                    |
| Area in tension                                       | A <sub>e</sub> =     | P <sub>t</sub> /( φ* F <sub>v</sub> ) |
|   | =                    | 0.4 cm <sup>2</sup>                   |
| Gross Area  | A <sub>g</sub> =     | A <sub>e</sub> +(d+.15)*t             |
|   | =                    | 1.03 cm <sup>2</sup>                  |
| Length in tension                                     | L <sub>t</sub> =     | A <sub>g</sub> /t                     |
|   | =                    | 1.72 cm                               |
| Edge distance of the                                  | e pin=               | 1.5*d                                 |
|   | =                    | 1.35 cm use 1.5cm                     |
| Edge distance on bo                                   | oth side=            | 2.7 cm                                |
|   |                      | 2.7 > 1.72                            |

| Design | of the | plate | connecting | cp01 | with | mast | 01 |
|--------|--------|-------|------------|------|------|------|----|
|        |        |       |            |      |      |      |    |

| Design of wel          | d on a            | rms                      | Fillet type weld                        |
|------------------------|-------------------|--------------------------|---|
| φ=                     | 0.75              |                          |   |
| $F_{E60} =$            | 42                | KN/cm <sup>2</sup>       |   |
| F <sub>w</sub> = 0.6*F | E60               |                          |   |
| Design strengt         | th per            | cm for .3cm o            | of weld= $0.75*0.6*F_{E60}*0.707*0.3$   |
|                        |                   |                          | = 4.0 KN/cm                             |
| Load on weld=          | =                 | 15                       | KN                                      |
| No. of weld=           |                   | 2                        |   |
| Load per weld          | =                 | 7.5                      | KN                                      |
| Required weld          | d lengt           | h=                       | 1.87 cm                                 |
| 8cm weld will          | be pro            | ovided                   |   |
| Design of the          | pin in            | double shear             | r                                       |
| φ=                     | 0.75              |                          |   |
| F <sub>u</sub> =       | 40                | KN/cm <sup>2</sup>       | ultimate strength                       |
| Area in shear          |                   | A <sub>sf</sub>          |   |
| Design load            |                   | P <sub>d</sub> =         | φ*0.6* F <sub>u</sub> * A <sub>sf</sub> |
| Design load            |                   | 15                       | KN                                      |
| Then                   | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6* | F <sub>u</sub> )                        |
|                        | =                 | 0.83                     | cm <sup>2</sup>                         |
| Area of the pi         | n=                | 0.42                     | cm <sup>2</sup>                         |
| Dia of the pin         | d=                | 0.73                     | cm                                      |
| use 1.2cm pin          |                   | PE 5                     |   |
| Design of the          | pin in            | bearing                  |   |
| φ=                     | 0.75              | _                        |   |
| F <sub>y</sub> =       | 24.5              | KN/cm <sup>2</sup>       | ultimate strength                       |
| Area in shear          |                   | d⊳*t                     |   |

ОК

| / i cu ili slicul     |     |    | upi              |   |  |  |  |
|-----------------------|-----|----|------------------|---|--|--|--|
| Design load           |     |    | P <sub>d</sub> = | φ*1.8* F <sub>y</sub> * d <sub>b</sub> *t |  |  |  |
| Design load           |     |    | 15               | KN  |  |  |  |
| d <sub>b</sub> =      | 1.2 | cm |                  |   |  |  |  |
| Thickness t=          |     |    | 0.38             | cm  |  |  |  |
| use 0.6cm thick plate |     |    |                  |   |  |  |  |

## Design of the plate in tension

| φ=               | 0.75 |                    |                                       |                 |
|------------------|------|--------------------|---------------------------------------|-----------------|
| F <sub>u</sub> = | 40   | KN/cm <sup>2</sup> |                                       |                 |
| Thickeness t=    |      | 0.6                | cm                                    |                 |
| Dia of pin d=    |      | 1.2                | cm                                    |                 |
| Tension load     | =    | 15                 | KN                                    |                 |
| Tension load     |      | P <sub>t</sub> =   | $\phi^* F_v^* A_e$                    |                 |
| Area in tensio   | n    | A <sub>e</sub> =   | P <sub>t</sub> /( φ* F <sub>v</sub> ) |                 |
|                  |      | =                  | 0.5                                   | cm <sup>2</sup> |
| Gross Area       |      | A <sub>g</sub> =   | A <sub>e</sub> +(d+.15)*t             |                 |
|                                 |                   |                    | =                 |                   | 1.31             | cm <sup>2</sup> |                              |          |
|---------------------------------|-------------------|--------------------|-------------------|-------------------|------------------|-----------------|------------------------------|----------|
| Length in tensi                 | on                |                    | L <sub>t</sub> =  | A <sub>g</sub> /t |                  |                 |                              |          |
|                                 | <b>6</b>          |                    | =                 |                   | 2.18             | ст              |                              |          |
| Edge distance                   | of the            | pin=               |                   | 1.5*d             |                  |                 |                              |          |
| Edgo distanco                   | on hot            | h cido-            | _ =               | 1.8               |                  | cm<br>2 G       | use 1.9 cm                   |          |
| Euge distance                   |                   | II side-           | -                 |                   | 36               | 5.0<br>>        | 2 18                         | ОК       |
|                                 | _                 |                    |                   |                   | 5.0              |                 | 2.10                         | ÖK       |
| Design of the p                 | olate c           | onnec              | ting m            | ast 01 a          | nd stay          | cable           |                              |          |
| Design of weld                  | 1 on ar           | ms                 |                   | Fillet ty         | pe wei           | a               |                              |          |
| φ=<br>E=                        | 0.75<br>12        | KN/cr              | n <sup>2</sup>    |                   |                  |                 |                              |          |
| $F_{\rm E60} = 0.6 * F_{\rm E}$ | 42                | KIN/ CI            |                   |                   |                  |                 |                              |          |
| Design strengt                  | h per o           | m for              | .3cm d            | of weld=          |                  |                 | 0.75*0.6*F <sub>F60</sub> *0 | .707*0.3 |
| 0 0                             | •                 |                    |                   |                   |                  | =               | 4.0 KN/cm                    |          |
| Load on weld=                   |                   |                    | 10                | KN                |                  |                 |                              |          |
| No. of weld=                    |                   |                    | 2                 |                   |                  |                 |                              |          |
| Load per weld                   | =                 |                    | 5                 | KN                |                  |                 |                              |          |
| Required weld                   | length            | 1=                 |                   |                   | 1.25             | cm              |                              |          |
| 7cm weld will l                 | be pro            | vided              |                   |                   |                  |                 |                              |          |
| Design of the p                 | oin in d          | double             | shea              | r                 |                  |                 |                              |          |
| ф=                              | 0.75              |                    |                   |                   |                  |                 |                              |          |
| F <sub>u</sub> =                | 40                | KN/cr              | n²                | ultimat           | e stren          | gth             |                              |          |
| Area in shear                   |                   |                    | $A_{sf}$          |                   |                  |                 |                              |          |
| Design load                     |                   |                    | P <sub>d</sub> =  | ф*0.6*            | $F_u^* A_{sf}$   |                 |                              |          |
| Design load                     |                   |                    | 10                | KN                |                  |                 |                              |          |
| Then                            | A <sub>sf</sub> = | Р <sub>d</sub> /(ф | *0.6*             | F <sub>u</sub> )  |                  |                 |                              |          |
| A                               | =                 |                    | 0.56              | cm <sup>2</sup>   |                  |                 |                              |          |
| Area of the pin                 | ר<br>ו=           |                    | 0.28              | cm-               |                  |                 |                              |          |
| Dia of the pin t                | בן=               |                    | 0.59              | cm                |                  |                 |                              |          |
| use .9cm pm                     |                   | PES                |                   |                   |                  |                 |                              |          |
| Design of the p                 | oin in l          | pearing            | g                 |                   |                  |                 |                              |          |
| φ=                              | 0.75              |                    | 2                 |                   |                  |                 |                              |          |
| F <sub>y</sub> =                | 24.5              | KN/cr              | n <sup>-</sup>    | ultimat           | e stren          | gth             |                              |          |
| Area in shear                   |                   |                    | d <sub>b</sub> ≁t | 1 * 1 0 *         | <b>-</b> * -   * |                 |                              |          |
| Design load                     |                   |                    | $P_d =$           | φ*1.8*            | Fy* ab*          | ť               |                              |          |
| Design Ioau                     | 1 2               | cm                 | 10                | KIN               |                  |                 |                              |          |
| ub-<br>Thickness t-             | 1.2               | CIII               | 0 25              | cm                |                  |                 |                              |          |
| use 0 6cm thic                  | k nlate           |                    | 0.25              | CIII              |                  |                 |                              |          |
| use otoern the                  | k plate           |                    |                   |                   |                  |                 |                              |          |
| Design of the                   | plate i           | n tens             | ion               |                   |                  |                 |                              |          |
| φ=<br>-                         | 0.75              |                    | . 2               |                   |                  |                 |                              |          |
| F <sub>u</sub> =                | 40                | KN/Cr              | n<br>O C          | <b></b>           |                  |                 |                              |          |
| Dia of nin d=                   |                   |                    | 0.0               | cm                |                  |                 |                              |          |
| Tension load -                  |                   |                    | 10                |                   |                  |                 |                              |          |
| Tension load                    |                   |                    | D                 | ли<br>            |                  |                 |                              |          |
| Area in tension                 | ı                 |                    | $A_{1}=$          | Ψ'vァ<br>P./(ሐ*    | ∿e<br>F…)        |                 |                              |          |
|                                 | •                 |                    | , .e              | 0.33              | 33333            | cm <sup>2</sup> |                              |          |
| Gross Area                      |                   |                    | A <sub>a</sub> =  | A_+(d+.           | 15)*t            |                 |                              |          |
|                                 |                   |                    | ъ<br>ты           | 0.96              | 53333            | cm <sup>2</sup> |                              |          |
| Length in tensi                 | on                |                    | L+=               | A₂/t              |                  | -               |                              |          |
|                                 |                   |                    | =                 | 0.                | 1.61             | cm              |                              |          |
| Edge distance                   | of the            | pin=               |                   | 1.5*d             |                  |                 |                              |          |
|                                 |                   |                    | =                 | 1.35              |                  | cm              | use 1.5 cm                   |          |
| Edge distance                   | on bot            | h side             | =                 |                   |                  | 2.7             | cm                           |          |
|                                 |                   |                    |                   |                   | 2.7              | >               | 1.61                         | OK       |

# Design of the bottom plate of mast 01

Design of weld Fillet type weld 0.75 φ= 42 KN/cm<sup>2</sup> F<sub>E60</sub>=  $F_{w} = 0.6*F_{E60}$  $0.75^* 0.6^* F_{E60}^* 0.707^* 0.3$ Design strength per cm for .3cm of weld= = 4.0 KN/cm Load on weld= 23.05 KN No. of weld= 2 Load per weld= 11.525 KN Required weld length= 2.88 cm 8.9cm weld will be provided

## Design of the pin in double shear

| φ=               | 0.75 |                    |   |
|------------------|------|--------------------|---|
| F <sub>u</sub> = | 40   | KN/cm <sup>2</sup> | ultimate strength                       |
| Area in shear    |      | A <sub>sf</sub>    |   |
| Design load      |      | P <sub>d</sub> =   | φ*0.6* F <sub>u</sub> * A <sub>sf</sub> |
| Design load      |      | 23.05              | KN                                      |

| Then             | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6 <sup>3</sup> | * F <sub>u</sub> )   |                                     |                 |            |
|------------------|-------------------|--------------------------------------|----------------------|-------------------------------------|-----------------|------------|
|                  | =                 | 1.28                                 | cm <sup>-</sup>      |                                     |                 |            |
| Area of the pi   | n=                | 0.64                                 | cm                   |                                     |                 |            |
| Dia of the pin   | a=                | 0.90                                 | cm                   |                                     |                 |            |
| use 1.2cm pin    |                   |                                      |                      |                                     |                 |            |
| Design of the    | pin in            | bearing                              |                      |                                     |                 |            |
| φ=               | 0.75              |                                      |                      |                                     |                 |            |
| F <sub>y</sub> = | 24.5              | KN/cm <sup>2</sup>                   | ultima               | te stren                            | gth             |            |
| Area in shear    |                   | d <sub>b</sub> *t                    |                      |                                     |                 |            |
| Design load      |                   | P <sub>d</sub> =                     | φ*1.8                | * F <sub>y</sub> * d <sub>b</sub> * | *t              |            |
| Design load      |                   | 23.05                                | KN                   |                                     |                 |            |
| d <sub>b</sub> = | 1.2               | cm                                   |                      |                                     |                 |            |
| Thickness t=     |                   | 0.58                                 | cm                   |                                     |                 |            |
| use 0.8cm thi    | ck plat           | е                                    |                      |                                     |                 |            |
| Design of the    | plate             | in tension                           |                      |                                     |                 |            |
| φ=               | 0.75              |                                      |                      |                                     |                 |            |
| F <sub>u</sub> = | 40                | KN/cm <sup>2</sup>                   |                      |                                     |                 |            |
| Thickeness t=    |                   | 0.8                                  | cm                   |                                     |                 |            |
| Dia of pin d=    |                   | 1.2                                  | cm                   |                                     |                 |            |
| Tension load     | =                 | 23.05                                | KN                   |                                     |                 |            |
| Tension load     |                   | P <sub>t</sub> =                     | φ* F <sub>v</sub> *  | A <sub>e</sub>                      |                 |            |
| Area in tensio   | n                 | A <sub>e</sub> =                     | P <sub>t</sub> /( φ* | * F <sub>v</sub> )                  |                 |            |
|                  |                   | =                                    |                      | 0.768                               | cm <sup>2</sup> |            |
| Gross Area       |                   | A <sub>g</sub> =                     | A <sub>e</sub> +(d+  | ·.15)*t                             |                 |            |
|                  |                   | =                                    |                      | 1.848                               | cm <sup>2</sup> |            |
| Length in tens   | sion              | L <sub>t</sub> =                     | A <sub>g</sub> /t    |                                     |                 |            |
|                  |                   | =                                    |                      | 2.31                                | ст              |            |
| Edge distance    | of the            | pin=                                 | 1.5*d                |                                     |                 |            |
|                  |                   | =                                    | 1.8                  |                                     | cm              | use 1.9 cm |
| Edge distance    | on bo             | th side=                             |                      | 3.6                                 | cm              |            |
|                  |                   |                                      |                      | 3.6                                 | >               | 2.31       |

ОК

ОК

# Design of the anchorage plate for mast 01

| Design of the pin in double shear |                   |                          |   |  |  |  |  |  |  |
|-----------------------------------|-------------------|--------------------------|---|--|--|--|--|--|--|
| φ=                                | 0.75              |                          |   |  |  |  |  |  |  |
| F <sub>u</sub> =                  | 40                | KN/cm <sup>2</sup>       | ultimate strength                       |  |  |  |  |  |  |
| Area in shear                     |                   | A <sub>sf</sub>          |   |  |  |  |  |  |  |
| Design load                       |                   | P <sub>d</sub> =         | φ*0.6* F <sub>u</sub> * A <sub>sf</sub> |  |  |  |  |  |  |
| Design load                       |                   | 23.05                    | KN                                      |  |  |  |  |  |  |
| Then                              | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6* | F <sub>u</sub> )                        |  |  |  |  |  |  |
|                                   | =                 | 1.28                     | cm <sup>2</sup>                         |  |  |  |  |  |  |
| Area of the pi                    | n=                | 0.64                     | cm <sup>2</sup>                         |  |  |  |  |  |  |
| Dia of the pin                    | d=                | 0.90                     | cm                                      |  |  |  |  |  |  |
| use 1.2cm pin                     |                   |                          |   |  |  |  |  |  |  |

## Design of the pin in bearing

| ф=                    | 0.75    |       |                   |                           |      |  |
|-----------------------|---------|-------|-------------------|---------------------------|------|--|
| F <sub>y</sub> =      | 24.5    | KN/   | cm <sup>2</sup>   | ultimate stre             | ngth |  |
| Area in shear         |         |       | d <sub>b</sub> *t |                           |      |  |
| Design load           |         |       | P <sub>d</sub> =  | φ*1.8* F <sub>y</sub> * d | ₀*t  |  |
| Design load           |         |       | 23.05             | KN                        |      |  |
| d <sub>b</sub> =      | 1.2     | cm    |                   |                           |      |  |
| Thickness t=          |         |       | 0.58              | cm                        |      |  |
| Thickness of ea       | ach pla | te t= |                   | 0.29                      | cm   |  |
| use 0.6cm thick plate |         |       |                   |                           |      |  |

## Design of the plate in tension

| φ= 0.75                |                    |                                       |                 |            |
|------------------------|--------------------|---------------------------------------|-----------------|------------|
| F <sub>u</sub> = 40    | KN/cm <sup>2</sup> |                                       |                 |            |
| Thickeness t=          | 0.6                | cm                                    |                 |            |
| Dia of pin d=          | 1.2                | cm                                    |                 |            |
| Tension load =         | 23.05              | KN                                    |                 |            |
| Tension load           | P <sub>t</sub> =   | $\phi^* F_v^* A_e$                    |                 |            |
| Area in tension        | A <sub>e</sub> =   | P <sub>t</sub> /( φ* F <sub>v</sub> ) |                 |            |
|                        | =                  | 0.768                                 | cm <sup>2</sup> |            |
| Gross Area             | A <sub>g</sub> =   | A <sub>e</sub> +(d+.15)*t             |                 |            |
|                        | =                  | 1.578                                 | cm <sup>2</sup> |            |
| Length in tension      | L <sub>t</sub> =   | A <sub>g</sub> /t                     |                 |            |
|                        | =                  | 2.63                                  | cm              |            |
| Edge distance of the p | oin=               | 1.5*d                                 |                 |            |
|                        | =                  | 1.8                                   | cm              | use 1.9 cm |
| Edge distance on both  | n side=            | 3.6                                   | cm              |            |
|                        |                    | 3.6                                   | >               | 2.63       |

73

| Design           | of weld             |       |                    | Fillet t | ld   |                   |  |
|------------------|---------------------|-------|--------------------|----------|------|-------------------|--|
| φ=               | (                   | ).75  |                    |          |      |                   |  |
| $F_{E60} =$      |                     | 42    | KN/cm <sup>2</sup> |          |      |                   |  |
| F <sub>w</sub> = | 0.6*F <sub>E6</sub> | 0     |                    |          |      |                   |  |
| Design           | strength            | per c | m for .3cm o       | f weld=  |      | 0.75*0.6*F<br>= 4 | E <sub>E60</sub> *0.707*0.3<br>4.0 KN/cm |
| Load or          | n weld=             |       | 23.05              | KN       |      |                   |  |
| No. of v         | veld=               |       | 2                  |          |      |                   |  |
| Load pe          | er weld=            |       | 11.525             | KN       |      |                   |  |
| Require          | d weld l            | ength | =                  |          | 2.88 | cm                |  |
| 8.9cm v          | veld will           | be pr | ovided             |          |      |                   |  |

# Design of the anchorage plate for mast 02

| Design of the p    | oin in c          | double shear             |                                       |                 |            |
|--------------------|-------------------|--------------------------|---------------------------------------|-----------------|------------|
| φ=                 | 0.75              |                          |                                       |                 |            |
| F <sub>u</sub> =   | 40                | KN/cm <sup>2</sup>       | ultimate stre                         | ngth            |            |
| Area in shear      |                   | A <sub>sf</sub>          |                                       |                 |            |
| Design load        |                   | P <sub>d</sub> =         | ф*0.6* F <sub>u</sub> * А             | sf              |            |
| Design load        |                   | 16.5                     | KN                                    |                 |            |
| Then               | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6* | F <sub>u</sub> )                      |                 |            |
|                    | =                 | 0.92                     | cm <sup>2</sup>                       |                 |            |
| Area of the pin    | =                 | 0.46                     | cm²                                   |                 |            |
| Dia of the pin d   | =                 | 0.76                     | cm                                    |                 |            |
| use 1.2cm pin      |                   |                          |                                       |                 |            |
| Design of the p    | oin in b          | pearing                  |                                       |                 |            |
| φ=                 | 0.75              | U                        |                                       |                 |            |
| F <sub>v</sub> =   | 24.5              | KN/cm <sup>2</sup>       | ultimate stre                         | ngth            |            |
| Area in shear      |                   | d <sub>b</sub> *t        |                                       |                 |            |
| Design load        |                   | P <sub>d</sub> =         | φ*1.8* F <sub>y</sub> * d             | <sub>b</sub> *t |            |
| Design load        |                   | 16.5                     | KN                                    |                 |            |
| d <sub>b</sub> =   | 1.2               | cm                       |                                       |                 |            |
| Thickness t=       |                   | 0.42                     | cm                                    |                 |            |
| Thickness of ea    | ich pla           | te t=                    | 0.21                                  | cm              |            |
| use 0.6cm thick    | < plate           | !                        |                                       |                 |            |
| Design of the      | plate i           | n tension                |                                       |                 |            |
| φ=                 | 0.75              |                          |                                       |                 |            |
| F <sub>u</sub> =   | 40                | KN/cm <sup>2</sup>       |                                       |                 |            |
| Thickeness t=      |                   | 0.6                      | cm                                    |                 |            |
| Dia of pin d=      |                   | 1.2                      | cm                                    |                 |            |
| Tension load =     |                   | 23.05                    | KN                                    |                 |            |
| Tension load       |                   | P <sub>t</sub> =         | $\varphi F_v A_e$                     |                 |            |
| Area in tension    |                   | A <sub>e</sub> =         | P <sub>t</sub> /( φ* F <sub>v</sub> ) | 2               |            |
|                    |                   | =                        | 0.768                                 | cm²             |            |
| Gross Area         |                   | A <sub>g</sub> =         | A <sub>e</sub> +(d+.15)*t             | 2               |            |
|                    |                   | =                        | 1.578                                 | cm²             |            |
| Length in tension  | on                | L <sub>t</sub> =         | A <sub>g</sub> /t                     |                 |            |
|                    | <b>C</b> 11       | =                        | 2.63                                  | cm              |            |
| Edge distance d    | of the            | pin=                     | 1.5*d                                 |                 |            |
| Edgo distanco d    | on hat            | =<br>h cido-             | 1.8                                   | cm              | use 1.9 cm |
| Euge distance (    | זסמ חכ            | n side=                  | 3.0                                   | CIII<br>N       | 2 62       |
|                    |                   |                          | 5.0                                   | >               | 2.05       |
| Design of weld     |                   |                          | Fillet type we                        | eld             |            |
| ф=                 | 0.75              | -                        |                                       |                 |            |
| F <sub>E60</sub> = | 42                | KN/cm <sup>2</sup>       |                                       |                 |            |

 $F_w$ = 0.6\*F<sub>E60</sub> Design strength per cm for .3cm of weld=

 $0.75*0.6*F_{E60}*0.707*0.3$ = 4.0 KN/cm

ОК

| Load on weld=             | 16.5 | KN   |    |  |
|---------------------------|------|------|----|--|
| No. of weld=              | 2    |      |    |  |
| Load per weld=            | 8.25 | KN   |    |  |
| Required weld length=     |      | 2.06 | cm |  |
| 8.9cm weld will be provid | ed   |      |    |  |

# Design of the plate connecting corner plate 02 with mast 02

| Design of weld       | on arn | าร                 | Fillet type weld |   |        |                             |      |
|----------------------|--------|--------------------|------------------|---|--------|-----------------------------|------|
| φ=                   | 0.75   |                    |                  |   |        |                             |      |
| F <sub>E60</sub> =   | 42     | KN/cm <sup>2</sup> |                  |   |        |                             |      |
| $F_{w} = 0.6*F_{EG}$ | 50     |                    |                  |   |        |                             |      |
| Design strength      | per cr | n for .3cm of w    | veld=            |   | 0.75*0 | ).6*F <sub>E60</sub> *0.707 | *0.3 |
|                      |        |                    |                  | = | 4.0    | KN/cm                       |      |
| Load on weld=        |        | 12                 | KN               |   |        |                             |      |

No. of weld= 2 6 KN Load per weld= Required weld length= 1.50 cm 7cm weld will be provided Design of the pin in double shear φ= 0.75 F<sub>u</sub>=  $40 \text{ KN/cm}^2$ ultimate strength Area in shear  $A_{sf}$ Design load  $P_{d} = \phi^{*} 0.6^{*} F_{u}^{*} A_{sf}$ Design load 12 KN  $A_{sf} = P_d / (\phi^* 0.6^* F_u)$ Then 0.67 cm<sup>2</sup> = Area of the pin= 0.33 cm<sup>2</sup> 0.65 cm Dia of the pin d= use .9cm pin PE 3 Design of the pin in bearing 0.75 φ= 24.5 KN/cm<sup>2</sup> ultimate strength F<sub>y</sub>= d<sub>b</sub>\*t Area in shear Design load  $P_{d} = \phi^{*} 1.8^{*} F_{y}^{*} d_{b}^{*} t$ Design load 12 KN d<sub>b</sub>= 0.9 cm Thickness t= 0.40 cm use 0.6cm thick plate Design of the plate in tension φ= 0.75 40 KN/cm<sup>2</sup>  $F_u =$ Thickeness t= 0.6 cm Dia of pin d= 0.9 cm Tension load = 12 KN Tension load P<sub>t</sub>=  $\phi^* F_v^* A_e$ Area in tension  $A_e = P_t / (\phi^* F_v)$  $0.4 \text{ cm}^2$ = Gross Area  $A_{g} = A_{e} + (d+.15)*t$ 1.03 cm<sup>2</sup> = Length in tension A<sub>g</sub>/t L<sub>t</sub>= = 1.72 cm Edge distance of the pin= 1.5\*d = 1.35 use 1.9 cm cm Edge distance on both side= 2.7 cm 2.7 1.72 > Design of the plate connecting mast 02 and stay cable Design of the pin in double shear φ= 0.75 40 KN/cm<sup>2</sup> ultimate strength

 $F_u =$ Area in shear  $A_{sf}$ Design load  $P_{d} = \phi^{*} 0.6^{*} F_{u}^{*} A_{sf}$ Design load 11 KN  $A_{sf} = P_d / (\phi^* 0.6^* F_u)$ Then 0.61 cm<sup>2</sup> = Area of the pin= 0.31 cm<sup>2</sup> 0.62 cm Dia of the pin d= use .9cm pin PE 3

ОК

## Design of the pin in bearing

| φ=               | 0.75 |                    |   |
|------------------|------|--------------------|---|
| F <sub>y</sub> = | 24.5 | KN/cm <sup>2</sup> | ultimate strength                         |
| Area in shear    |      | d <sub>b</sub> *t  |   |
| Design load      |      | P <sub>d</sub> =   | φ*1.8* F <sub>y</sub> * d <sub>b</sub> *t |
| Design load      |      | 11                 | KN  |

 $d_b$ = 1.2 cm Thickness t= 0.28 cm use 0.6cm thick plate

### Design of the plate in tension

| φ=               | 0.75 |                    |                                       |
|------------------|------|--------------------|---------------------------------------|
| F <sub>u</sub> = | 40   | KN/cm <sup>2</sup> |                                       |
| Thickeness t=    |      | 0.6                | cm                                    |
| Dia of pin d=    |      | 0.9                | cm                                    |
| Tension load =   |      | 11                 | KN                                    |
| Tension load     |      | P <sub>t</sub> =   | $\phi^* F_v^* A_e$                    |
| Area in tension  |      | A <sub>e</sub> =   | P <sub>t</sub> /( φ* F <sub>v</sub> ) |
|                  |      | =                  | 0.366667                              |
| Gross Area       |      | A <sub>g</sub> =   | A <sub>e</sub> +(d+.15)*t             |
|                  |      | =                  | 0.996667                              |
| Length in tensio | n    | L <sub>t</sub> =   | A <sub>g</sub> /t                     |

cm<sup>2</sup>

cm<sup>2</sup>

|                        |                   | =                        |                                 | 1.66  | cm   |                          |                         |
|------------------------|-------------------|--------------------------|---------------------------------|---|------|--------------------------|-------------------------|
| Edge distance          | of the p          | oin=                     | 1.5*d                           |   |      |                          |                         |
|                        |                   | =                        | 1.35                            |   | cm   | use 1.5 cm               |                         |
| Edge distance          | on both           | n side=                  |                                 |   | 2.7  | cm                       |                         |
| -                      |                   |                          |                                 | 2.7   | >    | 1.66                     | ОК                      |
|                        |                   |                          | <b></b>                         |   |      |                          |                         |
| Design of weld         | d on arr          | ns                       | Fillet ty                       | /pe weld                                      |      |                          |                         |
| φ=                     | 0.75              |                          |                                 |   |      |                          |                         |
| F <sub>E60</sub> =     | 42                | KN/cm²                   |                                 |   |      |                          |                         |
| F <sub>w</sub> = 0.6*F | E60               |                          |                                 |   |      |                          |                         |
| Design strengt         | h per ci          | m for .3cm of            | weld=                           |   |      | 0.75*0.6*F <sub>E6</sub> | <sub>0</sub> *0.707*0.3 |
|                        |                   |                          |                                 |   | =    | 4.0 KN/0                 | cm                      |
| Load on weld=          | :                 | 11                       | KN                              |   |      |                          |                         |
| No. of weld=           |                   | 2                        |                                 |   |      |                          |                         |
| Load per weld          | =                 | 5.5                      | KN                              |   |      |                          |                         |
| Required weld          | length            | =                        |                                 | 1.37  | cm   |                          |                         |
| 8cm weld will          | be prov           | vided                    |                                 |   |      |                          |                         |
| Design of the          | h                 | alata of mos             | + 02                            |   |      |                          |                         |
| Design of the          | octom             | plate of mas             |                                 |   |      |                          |                         |
| Design of the          | pin in d          | ouble shear              |                                 |   |      |                          |                         |
| ф=                     | 0.75              |                          |                                 |   |      |                          |                         |
| F <sub>u</sub> =       | 40                | KN/cm <sup>2</sup>       | ultimat                         | te streng                                     | th   |                          |                         |
| Area in shear          |                   | A <sub>sf</sub>          |                                 | -   |      |                          |                         |
| Design load            |                   | P <sub>d</sub> =         | φ*0.6*                          | <sup>•</sup> F <sub>u</sub> * A <sub>sf</sub> |      |                          |                         |
| Design load            |                   | 16.5                     | KN                              |   |      |                          |                         |
| Then                   | A <sub>sf</sub> = | P <sub>d</sub> /( φ*0.6* | F <sub>u</sub> )                |   |      |                          |                         |
|                        | =                 | 0.92                     | cm <sup>2</sup>                 |   |      |                          |                         |
| Area of the pir        | ו=                | 0.46                     | cm <sup>2</sup>                 |   |      |                          |                         |
| Dia of the pin (       | d=                | 0.76                     | cm                              |   |      |                          |                         |
| use 1.2cm pin          |                   |                          |                                 |   |      |                          |                         |
|                        |                   |                          |                                 |   |      |                          |                         |
| Design of the          |                   | earing                   |                                 |   |      |                          |                         |
| φ=<br>-                | 0.75              | 1/11/2                   | . 1.2                           |   | 4 In |                          |                         |
| ⊢ <sub>y</sub> =       | 24.5              | KIN/CM <sup>-</sup>      | ultimat                         | te streng                                     | n    |                          |                         |
| Area in shear          |                   | d <sub>b</sub> *t        | 144 24                          |   |      |                          |                         |
| Jesign load            |                   | $P_d =$                  | φ*1.8*                          | ⁻⊦ <sub>y</sub> * d <sub>b</sub> *t           |      |                          |                         |
| Design load            |                   | 16.5                     | KN                              |   |      |                          |                         |
| d <sub>b</sub> =       | 1.2               | cm                       |                                 |   |      |                          |                         |
| Thickness t=           |                   | 0.42                     | cm                              |   |      |                          |                         |
| use 0.8cm thic         | k plate           |                          |                                 |   |      |                          |                         |
| Design of the          | plate in          | n tension                |                                 |   |      |                          |                         |
| <br>                   | 0 75              |                          |                                 |   |      |                          |                         |
| Ψ <sup>-</sup><br>F =  | 0.75<br>۸۸        | KN/cm <sup>2</sup>       |                                 |   |      |                          |                         |
| Thickeness +-          | 40                |                          | cm                              |   |      |                          |                         |
| Dia of nin d-          |                   | 0.0<br>1 ว               | cm                              |   |      |                          |                         |
| Tension load -         |                   | 1.∠<br>22 ∩⊑             | KN                              |   |      |                          | OK                      |
|                        |                   | 23.U3<br>– ח             | ки<br>• * = *                   | ٨   |      |                          | UK                      |
|                        | <b>.</b>          | ν <sub>t</sub> =         | Ψ΄ F <sub>V</sub> ″/<br>D // ±* | н <sub>е</sub><br>г)                          |      |                          |                         |
| Area in tensior        | 1                 | A <sub>e</sub> =         | Р <sub>t</sub> /(Ф*             | rv)   |      |                          |                         |
| <b>.</b>               |                   | =                        |                                 | U./68   | cm   |                          |                         |
| Gross Area             |                   | A <sub>g</sub> =         | A <sub>e</sub> +(d+             | .15)*t  | 2    |                          |                         |
|                        |                   | =                        |                                 | 1.848   | cm   |                          |                         |
| Length in tensi        | ion               | L <sub>t</sub> =         | A <sub>g</sub> /t               | <b>-</b> -                                    |      |                          |                         |
|                        |                   | =                        |                                 | 2.31  | cm   |                          |                         |
| Edge distance          | of the p          | pin=                     | 1.5*d                           |   |      |                          |                         |
|                        |                   | =                        | 1.8                             |   | cm   | use 1.9 cm               |                         |
| Edge distance          | on botł           | n side=                  |                                 | 3.6   | cm   |                          |                         |
|                        |                   |                          |                                 | 3.6   | >    | 2.31                     |                         |
| Design of wold         | 4                 |                          | Fillot to                       | ine wold                                      |      |                          |                         |
|                        | <b>,</b><br>0.75  |                          | rinet (y                        | vhe weig                                      |      |                          |                         |
| Ψ-                     | 0.75              | $KN/cm^2$                |                                 |   |      |                          |                         |
| FE60=                  | 42                | KIN/CITI                 |                                 |   |      |                          |                         |
| r <sub>w</sub> = U.6*⊦ | E60               |                          |                                 |   |      |                          |                         |

| Design strength p | r cm for .3cm of weid= |
|-------------------|------------------------|
|-------------------|------------------------|

 $0.75*0.6*F_{E60}*0.707*0.3$ = 4.0 KN/cm

Load on weld=16.5KNNo. of weld=2Load per weld=8.25KNRequired weld length=27cm weld will be provided2

2.06 cm

## **Design of Masts M01**

Forces F= 23.05 KN Length L= 600cm Section Property Dia 89.1mm, Thk 2.5mm Material A53 grade B(pipe)

Gross Area  $A_g$ = 6.79cm<sup>2</sup> Moment of Inertia I= 63.37cm<sup>4</sup> Radius of Gyration r= 3.06cm

## K= 1

## **Design of Masts M02**

Forces F= 16.46 KN Length L= 350cm Section Property Dia 60.3mm, Thk 2mm Material A53 grade B(pipe)

Gross Area A<sub>g</sub>= 3.66cm<sup>2</sup> Moment of Inertia I= 15.58cm<sup>4</sup> Radius of Gyration r= 2.06cm

 $\begin{array}{l} \mbox{K= 1} \\ \mbox{KL/r= 169.7} \\ \mbox{Slenderness parameter } \lambda_c = (\mbox{KL/r\pi})\mbox{Sqrt}(\mbox{F}_{\mbox{y}}/\mbox{E}) \\ &= 1.848289 \ (\mbox{F}_{\mbox{y}} = 24\mbox{KN/cm}^2, \mbox{E} = 20500\mbox{KN/cm}^2) \\ \mbox{Since, } \lambda_c \mbox{>} 1.5 \\ \mbox{Then, Critical Stress F}_{cr} \mbox{ material side} = (0.877/\ \lambda_c^2)\mbox{F}_{\mbox{y}} \\ &= 6.16\ \mbox{KN/cm}^2 \\ \mbox{Resistance factor } \varphi_c \mbox{=} 0.85 \\ \mbox{Design Strength P}_{\mbox{n}} \mbox{=} A_g\ \mbox{F}_{cr} \\ &= 22.57\ \mbox{KN} \\ \mbox{Factored Strength } \varphi_c\ \mbox{P}_{\mbox{n}} \mbox{=} 19.18\ \mbox{KN > 16.46\ \mbox{KN} \ \ \mbox{OK} \end{array}$ 

Uplift resistance capacity of the Foundation Unit weight of soil (fill) and concrete= Pressure of this material at 80cm=

19.6375 KN/m3 15.71 KN/m2







|                                 | 0.001571 | KN/cm2 |         |
|---------------------------------|----------|--------|---------|
| Assume allowable soil pressure= | 3.45     | KN/cm2 |         |
| Available bearing               |          |        |         |
| pressure=                       | 3.44843  | KN/cm2 |         |
| Load on                         |          |        |         |
| footing=                        | 23.05    | KN     |         |
| Required area for               |          |        | Mast02  |
| footing=                        | 6.6842   | cm2    | 1113(02 |
| A footing base 76x76cm2 is      |          |        |         |
| provided                        |          |        |         |