|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **طرح نگهداشت و افزایش تولید 27 مخزن** | | | | | | | |
| **ROOF STRUCTURE CALCULATION FOR FIRE WATER TANKS (TK-2301 A/B)**  **نگهداشت و افزایش تولید میدان نفتی بینک** | | | | | | | |
|  |  |  |  |  |  |  |
|  |  |  |  |  |  |  |
| V02 | Mar. 2025 | IFI | IDR | M.Fakharian | S.Faramarzpour |  |
| V01 | Dec. 2024 | IFI | IDR | M.Fakharian | S.Faramarzpour |  |
| V00 | NOV. 2024 | IFI | IDR | M.Fakharian | M.Sadeghian |  |
| **Rev.** | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
|  | | | | | | |
| **Status:** | **IFA: Issued For Approval**  **IFI: Issued For Information**  **AFC: Approved For Construction** | | | | | |

**REVISION RECORD SHEET**

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **PAGE** | **V00** | **V01** | **V02** | **V03** | **V04** |  | **PAGE** | **V00** | **V01** | **V02** | **V03** | **V04** |
| **1** | X | X | X |  |  | **66** |  |  |  |  |  |
| **2** | X | X | X |  |  | **67** |  |  |  |  |  |
| **3** | X | X | X |  |  | **68** |  |  |  |  |  |
| **4** | X | X | X |  |  | **69** |  |  |  |  |  |
| **5** | X | X | X |  |  | **70** |  |  |  |  |  |
| **6** | X | X | X |  |  | **71** |  |  |  |  |  |
| **7** | X | X | X |  |  | **72** |  |  |  |  |  |
| **8** | X | X | X |  |  | **73** |  |  |  |  |  |
| **9** | X | X | X |  |  | **74** |  |  |  |  |  |
| **10** | X | X | X |  |  | **75** |  |  |  |  |  |
| **11** | X | X | X |  |  | **76** |  |  |  |  |  |
| **12** |  | X | X |  |  | **77** |  |  |  |  |  |
| **13** |  | X | X |  |  | **78** |  |  |  |  |  |
| **14** |  | X | X |  |  | **79** |  |  |  |  |  |
| **15** |  | X | X |  |  | **80** |  |  |  |  |  |
| **16** |  | X | X |  |  | **81** |  |  |  |  |  |
| **17** |  | X | X |  |  | **82** |  |  |  |  |  |
| **18** |  |  | X |  |  | **83** |  |  |  |  |  |
| **19** |  |  | X |  |  | **84** |  |  |  |  |  |
| **20** |  |  | X |  |  | **85** |  |  |  |  |  |
| **21** |  |  | X |  |  | **86** |  |  |  |  |  |
| **22** |  |  | X |  |  | **87** |  |  |  |  |  |
| **23** |  |  | X |  |  | **88** |  |  |  |  |  |
| **24** |  |  |  |  |  | **89** |  |  |  |  |  |
| **25** |  |  |  |  |  | **90** |  |  |  |  |  |
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| **32** |  |  |  |  |  | **97** |  |  |  |  |  |
| **33** |  |  |  |  |  | **98** |  |  |  |  |  |
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| **44** |  |  |  |  |  | **109** |  |  |  |  |  |
| **45** |  |  |  |  |  | **110** |  |  |  |  |  |
| **46** |  |  |  |  |  | **111** |  |  |  |  |  |
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| **49** |  |  |  |  |  | **114** |  |  |  |  |  |
| **50** |  |  |  |  |  | **115** |  |  |  |  |  |
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| **55** |  |  |  |  |  | **120** |  |  |  |  |  |
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| **57** |  |  |  |  |  | **122** |  |  |  |  |  |
| **58** |  |  |  |  |  | **123** |  |  |  |  |  |
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1. **INTRODUCTION**

Binak oilfield in Bushehr province is a part of the southern oilfields of Iran, is located 20 km northwest of Genaveh city.

With the aim of increasing production of oil from Binak oilfield, an EPC/EPD Project has been defined by NIOC/NISOC and awarded to Petro Iran Development Company (PEDCO). Also PEDCO (as General Contractor) has assigned the EPC-packages of the Project to "Hirgan Energy - Design and Inspection" JV.

**GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT: | National Iranian South Oilfields Company (NISOC) |
| PROJECT: | Binak Oilfield Development – SUPPLY STORAGE TANK |
| EPD/EPC CONTRACTOR (GC): | Petro Iran Development Company (PEDCO) |
|  |  |
| EPC CONTRACTOR: | Joint Venture of : Hirgan Energy – Design & Inspection(D&I) Companies |
| VENDOR: | IDRIL KHAVARMIANEH (IDR) |
| EXECUTOR: | Executor is the party which carries out all or part of construction and/or commissioning for the project. |
| THIRD PARTY INSPECTOR (TPI): | Third Party Inspector |
| SHALL: | Is used where a provision is mandatory. |
| SHOULD: | Is used where a provision is advisory only. |
| WILL: | Is normally used in connection with the action by CLIENT rather than by an EPC/EPD CONTRACTOR, supplier or VENDOR. |
| MAY: | Is used where a provision is completely discretionary. |
|  |  |

1. ***USING CODES:***

The codes, used for analysis and design of this Structure are:

* AISC-360-10-ASD for Steel Design
* API 650-2021 (Welded Tanks for Oil Storage)
* MECHANICAL GA For Fire Water Tank 2031A
* National Building Regulations-Topic 10
* 2800 Code for seismic design of buildings
* National Building Regulations- Topic 6
* Iranian Seismic Design Code for Oil industries (3nd Edition)-1395 (Pub No.38)

1. ***TRIAL SIZING:***

* Roof type: Cone Tank Diameter: ID 13.0 m
* Tank Height: 9.5 m
* Roof ceiling Slope: 5.7’≡10%
* Roof Ceiling Thk.: 8 mm
* No. Of Beam: 24
* Beam Section : IPE 160
* Lateral Beam Section: L80x8

1. ***LOADING:***

The design loads applied for structural analysis include Dead load, Live load, wind load and Seismic load.

**A) Dead Load:**

**AI) Ceiling:**

**1-Roof:**

Plate 8 mm

**AII) Structure**

SAP2000 Software has considered weight of structural members automatically.

**B) Snow Load(S):**

**1-Roof:**

**(Binak)** ;

; ; ;

**B) Live Load (LLr):**

L.L=100  According to API 650 - Edition 2021

**C) Asymmetric Snow Load:**

According to National Building Regulations- Topic 6

* α=5.7’ ≡10% ≥ 4%

S1=7.11× (0.29~1.7) = (2.06~12.09)

S2=23.7× (1.04~1.7) = (24.65~40.29)

S3=48.5× (0.29~1.04) = (14.07~50.44)

**D) Wind Load:**

Wind loads have been calculated according to:

**;** *V=120 km/hr;* ****

****

 According to National Building Regulations-Topic 6





;

;

For any Direction:

; 

For any Direction:

*P2E=68×1.2×1.0×-2= -163.2 kg/m² (0.29 m to 1.7 m) P2E= (47.3-277.4)*

*P3E=68×1.2×1.0×-1.0= -81.6 kg/m²; (0.29 m to 1.7 m) P3E= (23.7-138.7)*

Finally total loads would be as below:

These wind loads have been applied to roof structural members in sap2000 model with respect to their share of roof area.

**E) Seismic Load:**

Earthquake loads have been calculated according to 038 & API650 13 ED. Code for seismic design of buildings:

*Seismic Use Group: III*

*Soil Type: IV (Worst Case)*

*Important factor (I): 1.5*

*Scaling Factor (Q) 1.0*

*Ai= SDSI/R*

*S1=0.46 Ss=1.125*

*SDS=0.75 SD1=0.41*

*T0=0.2 SD1/ SDS=0.11 Ts= SD1/ SDS=0.546*

*T0 < T=0.3 < Ts SA=SDS*

*R=3.5 Ai= SDSI/R=0.32*

*:* Weight of building which participate in earthquake.

Earthquake loads have been calculated according to 2800 Code for seismic design of buildings:

*Soil Type: IV Ts=1.0 T0=0.15 T=0.05H0.75=0.3*

*Important factor (I): 1.4*

*S0=1.1 S=1.75 Iw=1.4 B1=1+S=2.75*

*C=ABI/R=0.3×2.75×1.4/3.5=0.33*

*Vumin=1.6AIW/Ru: Ru=3.5 Vumin=0.224W Cmin=0.224*

*Vertical Seismic Load: (Bay=13 m<15 m → Not Needed)*

*Ev=0.6AI × (W) =0.252W (According to 2800)*

These seismic loads have been applied to all points in sap2000 model automatically by sap2000 program.

**Tank Sizing:**

* Roof type: Cone Tank Diameter: ID 13.0 m
* Tank Height: 9.5 m
* Roof ceiling Slope: 5.7’≡10%
* Roof Ceiling Thk.: 8 mm
* No. Of Beam: 24
* Beam Section : IPE 160
* Lateral Beam Section: L80x8

1. ***STRUCTURE* *ANALYSIS:***

The 3-dimensional structural analysis will be performed using “SAP 2000 V. 19”

* 1. ***General Input Data:***

Table: Coordinate Systems

| Table: Coordinate Systems | | |
| --- | --- | --- |
| Name | Type | X | | Y | Z | AboutZ | AboutY | AboutX |
|  |  | m | | m | m | Degrees | Degrees | Degrees |
| GLOBAL | Cylindrical | 0. | | 0. | 0. | 0. | 0. | 0. |

Table: Grid Lines

|  |  | | |  | | Table: Grid Lines, | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Coord  Sys | | Axis  Dir | Grid  ID | | XRYZ  Coord | | TAngle | LineType | Line  Color | | Visible | Bubble  Loc | All  Visible | Bubble  Size |
|  | |  |  | | m | | Degrees |  |  | |  |  |  | m |
| GLOBAL | | R | A | | 0. | |  | Primary | 10461087 | | Yes | End | Yes | 0.25 |
| GLOBAL | | R | B | | 1.1 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | R | E | | 3.26 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | R | C | | 4.88 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | R | D | | 6.5 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 1 | |  | | 0. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 2 | |  | | 15. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 3 | |  | | 30. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 4 | |  | | 45. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 5 | |  | | 60. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 6 | |  | | 75. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 7 | |  | | 90. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 8 | |  | | 105. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 9 | |  | | 120. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 10 | |  | | 135. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 11 | |  | | 150. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 12 | |  | | 165. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 13 | |  | | 180. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 14 | |  | | 195. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 15 | |  | | 210. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 16 | |  | | 225. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 17 | |  | | 240. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 18 | |  | | 255. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 19 | |  | | 270. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 20 | |  | | 285. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 21 | |  | | 300. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 22 | |  | | 315. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 23 | |  | | 330. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | T | 24 | |  | | 345. | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | Z | Z1 | | 0. | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | Z | Z2 | | 0.195 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | Z | Z2.1 | | 0.39 | |  | Primary | 10461087 | | Yes | End |  |  |
| GLOBAL | | Z | Z3 | | 0.65 | |  | Primary | 10461087 | | Yes | End |  |  |

Table: Material Properties 03a - Steel Data,

|  |  | | Table: Material Properties 03a - | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Material | | Fy | | Fu | EffFy | EffFu | SSCurve  Opt | | SSHys  Type | SHard | SMax | SRup | FinalSlope |
|  | | Kgf/m2 | | Kgf/m2 | Kgf/m2 | Kgf/m2 |  | |  |  |  |  |  |
| ST37 | | 24000000. | | 37000000. | 24000000. | 37000000. | Simple | | Kinematic | 0.02 | 0.14 | 0.2 | -0.1 |

Table: Frame Section Properties 01 - General, Part 1 of 5

| Table: Frame Section Properties 01 - General, Part 1 of 5 | | | | | |  | |  | |  | |  | |  | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Section  Name | Material | Shape | t3 | t2 | tf | | tw | | t2b | | tfb | | Area | | Tors  Const | | I33 |
|  |  |  | m | m | m | | m | | m | | m | | m2 | | m4 | | m4 |
| B1 | ST37 | SD Section |  |  |  | |  | |  | |  | | 0.0092 | | 0.000088 | | 0.000047 |
| IPE160 | ST37 | I/Wide Flange | 0.16 | 0.082 | 0.0074 | | 0.005 | | 0.082 | | 0.0074 | | 0.00201 | | 3.540E-08 | | 8.690E-06 |
| L80X8 | ST37 | Angle | 0.08 | 0.08 | 0.008 | | 0.008 | |  | |  | | 0.001227 | | 2.594E-08 | | 7.224E-07 |

Table: Frame Section Properties 01 - General, Part 2 of 5

| Section  Name | I22 | I23 | AS2 | AS3 | S33 | S22 | Z33 | Z22 | R33 |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | m4 | m4 | m2 | m2 | m3 | m3 | m3 | m3 | m |
| B1 | 0.000085 | 0. | 0.003284 | 0.006096 | 0.000468 | 0.000635 | 0.000544 | 0.000788 | 0.071322 |
| IPE160 | 6.830E-07 | 0. | 0.0008 | 0.001011 | 0.000109 | 0.000017 | 0.000124 | 0.000026 | 0.065752 |
| L80X8 | 7.224E-07 | 4.365E-07 | 0.00064 | 0.00064 | 0.000013 | 0.000013 | 0.000023 | 0.000023 | 0.024264 |

Table: Frame Section Properties 01 - General, Part 4 of 5

| Table: Frame Section Properties 01 - General, Part 4 of 5 | | | | | |  | |  | |  | |  | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Section  Name | R22 | Conc  Col | Conc  Beam | Color | Total  Wt | | Total  Mass | | From  File | | A  Mod | | A2  Mod | | A3  Mod | J  Mod |
|  | m |  |  |  | Kgf | | Kgf-s2/m | |  | |  | |  | |  |  |
| B1 | 0.095848 | No | No | Red | 497.72 | | 50.75 | | No | | 1. | | 1. | | 1. | 1. |
| IPE160 | 0.018434 | No | No | Magenta | 2059.65 | | 210.03 | | Yes | | 1. | | 1. | | 1. | 1. |
| L80X8 | 0.024264 | No | No | White | 491.22 | | 50.09 | | Yes | | 1. | | 1. | | 1. | 1. |

Table: Frame Section Properties 01 - General, Part 5 of 5

| Section  Name | I2  Mod | I3  Mod | M  Mod | W  Mod | SectIn  File | FileName | GUID | Notes |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |  |  |  |
| B1 | 1. | 1. | 1. | 1. |  |  |  | Added 3/29/2017 11:02:44 AM |
| IPE160 | 1. | 1. | 1. | 1. | IPE160 | c:\program files\computers and structures\sap2000 19\euro.pro |  | Imported 3/29/2017 12:37:25 PM from Euro.pro |
| L80X8 | 1. | 1. | 1. | 1. | L80X8 | c:\program files\computers and structures\sap2000 19\euro.pro |  | Imported 3/29/2017 12:37:48 PM from Euro.pro |

Table: Area Section Properties, Part 1 of 3

| Table: Area Section Properties, Part 1 of 3 | | | | |  |  | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Section | Material | Mat  Angle | Area  Type | Type | | Drill  DOF | Thickness | | Bend  Thick | Arc | In  Comp | Coord  Sys |
|  |  | Degrees |  |  | |  | m | | m | Degrees |  |  |
| Roof Shell | ST37 | 0. | Shell | Shell-Thin | | Yes | 0.008 | | 0.008 |  |  |  |

Table: Area Section Properties, Part 2 of 3

| Section | Color | Total  Wt | Total  Mass | F11  Mod | F22  Mod | F12  Mod | M11  Mod | M22  Mod | M12  Mod | V13  Mod | V23  Mod | MMod | WMod |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  |  | Kgf | Kgf-s2/m |  |  |  |  |  |  |  |  |  |  |
| Roof Shell | Yellow | 8063.47 | 822.24 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 0.01 | 1. | 1. | 1. | 1. |

Table: Area Section Properties, Part 3 of 3

| Table: Area Section Properties, Part 3 of 3 | | |
| --- | --- | --- |
| Section | GUID | Notes |
|  |  |  |
| Roof Shell |  | Added 2008/01/06 01:34:38 ?.? |

Table: Load Pattern Definitions

| Table: Load Pattern Definitions | |
| --- | --- |
| LoadPat | Design  Type | | Self  WtMult | AutoL  oad | GUID | Notes |
|  |  | |  |  |  |  |
| DEAD | Dead | | 1. |  |  |  |
| LL | Live | | 0. |  |  |  |
| WIND | Wind | | 0. | None |  |  |
| Snow(asymmetric) | Snow | | 0. |  | aeef0373-9b98-4d99-b7a1-dcaac379e965 |  |
| Temp.(+) | Temperature | | 0. |  | 44417da3-c2fc-4bfe-b219-b86b39c398ca |  |
| EQ | Quake | | 0. | USER COEFF | db46d43c-7d7b-406a-b0c4-728182458b82 |  |
| Temp.(-) | Temperature | | 0. |  | d826c701-cd22-43ec-84aa-43bd382e9575 |  |
| EQ(V) | Other | | 0.252 |  | 980ede88-2c1c-42b1-bbaa-0b30ecc947ad |  |

Table: Case - Static 1 - Load Assignments

| Table: Case - Static 1 - Load Assignments | | | |
| --- | --- | --- | --- |
| Case | LoadType | LoadName | LoadSF |
|  |  |  |  |
| DEAD | Load pattern | DEAD | 1. |
| WIND | Load pattern | WIND | 1. |
| LIVE | Load pattern | LL | 1. |
| LIVE | Load pattern | LL | 1. |
| LL(asymmetric) | Load pattern | Snow(asymmetric) | 1. |
| Temp.(+) | Load pattern | Temp.(+) | 1. |
| EQ | Load pattern | EQ | 1. |
| Temp.(-) | Load pattern | Temp.(-) | 1. |
| EQ(V) | Load pattern | EQ(V) | 1. |

Table: Load Case Definitions, Part 1 of 2

| Table: Load Case Definitions, Part 1 of 2 | | | |  | | |  | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Case | Type | Initial  Cond | Modal  Case | | Base  Case | Mass  Source | | Des  TypeOpt | | Design  Type | Des  ActOpt | Design  Act |
|  |  |  |  | |  |  | |  | |  |  |  |
| DEAD | LinStatic | Zero |  | |  |  | | Prog Det | | Dead | Prog Det | Non-Composite |
| MODAL | LinModal | Zero |  | |  |  | | Prog Det | | Other | Prog Det | Other |
| WIND | LinStatic | Zero |  | |  |  | | Prog Det | | Wind | Prog Det | Short-Term Composite |
| LIVE | LinStatic | Zero |  | |  |  | | Prog Det | | Live | Prog Det | Short-Term Composite |
| LL(asymmetric) | LinStatic | Zero |  | |  |  | | Prog Det | | Snow | Prog Det | Short-Term Composite |
| Temp.(+) | LinStatic | Zero |  | |  |  | | Prog Det | | Temperature | Prog Det | Short-Term Composite |
| EQ | LinStatic | Zero |  | |  |  | | Prog Det | | Quake | Prog Det | Short-Term Composite |
| Temp.(-) | LinStatic | Zero |  | |  |  | | Prog Det | | Temperature | Prog Det | Short-Term Composite |
| EQ(V) | LinStatic | Zero |  | |  |  | | Prog Det | | Other | Prog Det | Other |

Table: Load Case Definitions, Part 2 of 2

| Case | Auto  Type | Run  Case | Case  Status | GUID | Notes |
| --- | --- | --- | --- | --- | --- |
|  |  |  |  |  |  |
| DEAD | None | Yes | Finished |  |  |
| MODAL | None | Yes | Finished |  |  |
| WIND | None | Yes | Finished |  |  |
| LIVE | None | Yes | Finished |  |  |
| LL(asymmetric) | None | Yes | Finished | 832c8f9c-a30d-4be5-a81e-8f5312ff9a26 |  |
| Temp.(+) | None | Yes | Finished | d745dd9f-4da3-4517-a618-f9690fede060 |  |
| EQ | None | Yes | Finished | cf38ebd5-59dd-466d-a44c-c6de0ad746a7 |  |
| Temp.(-) | None | Yes | Finished | f8930cf6-ac23-49bd-bf51-c3c239085e05 |  |
| EQ(V) | None | Yes | Finished | 64cd170c-b5d1-4275-8038-c69bc1625fca |  |

Table: Auto Seismic - User Coefficient

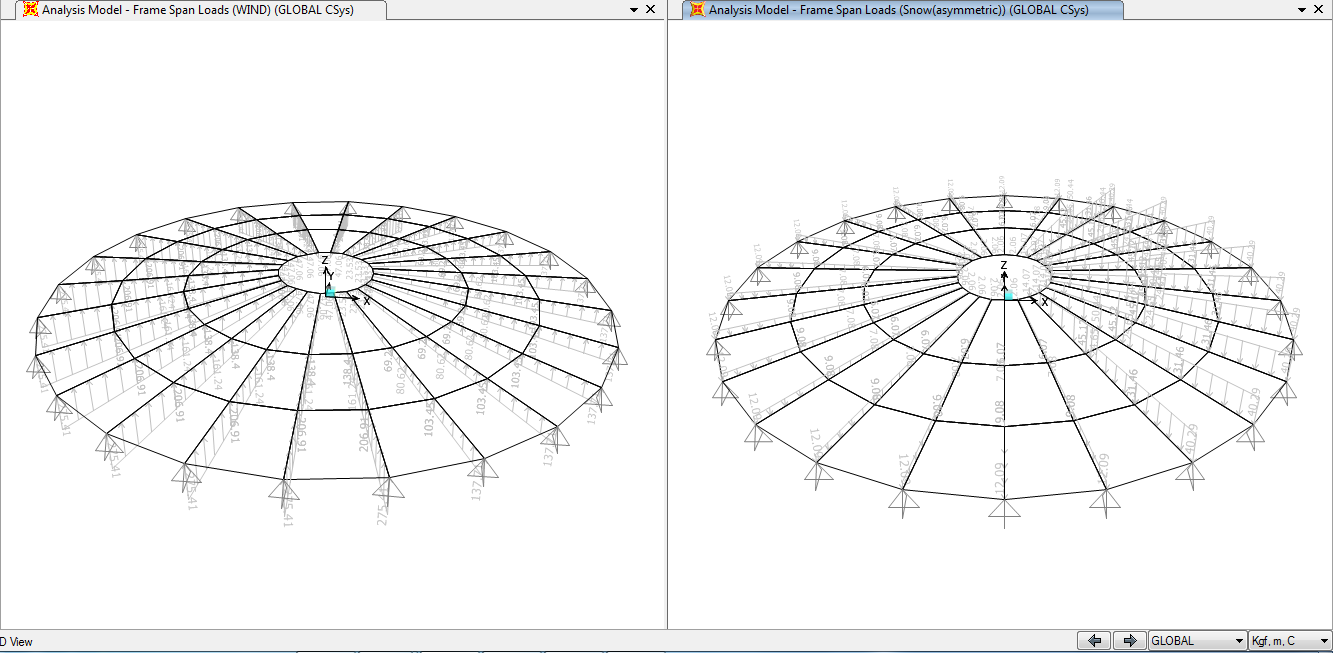
| Table: Auto Seismic - User Coefficient, | | | | | |  | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Load  Pat | Dir | Percent  Ecc | Ecc  Override | UserZ | C | | K | Weight  Used | | Base  Shear |
|  |  |  |  |  |  | |  | Kgf | | Kgf |
| EQ | X | 0.05 | No | No | 0.35 | | 1. | 12907.99 | | 4517.8 |

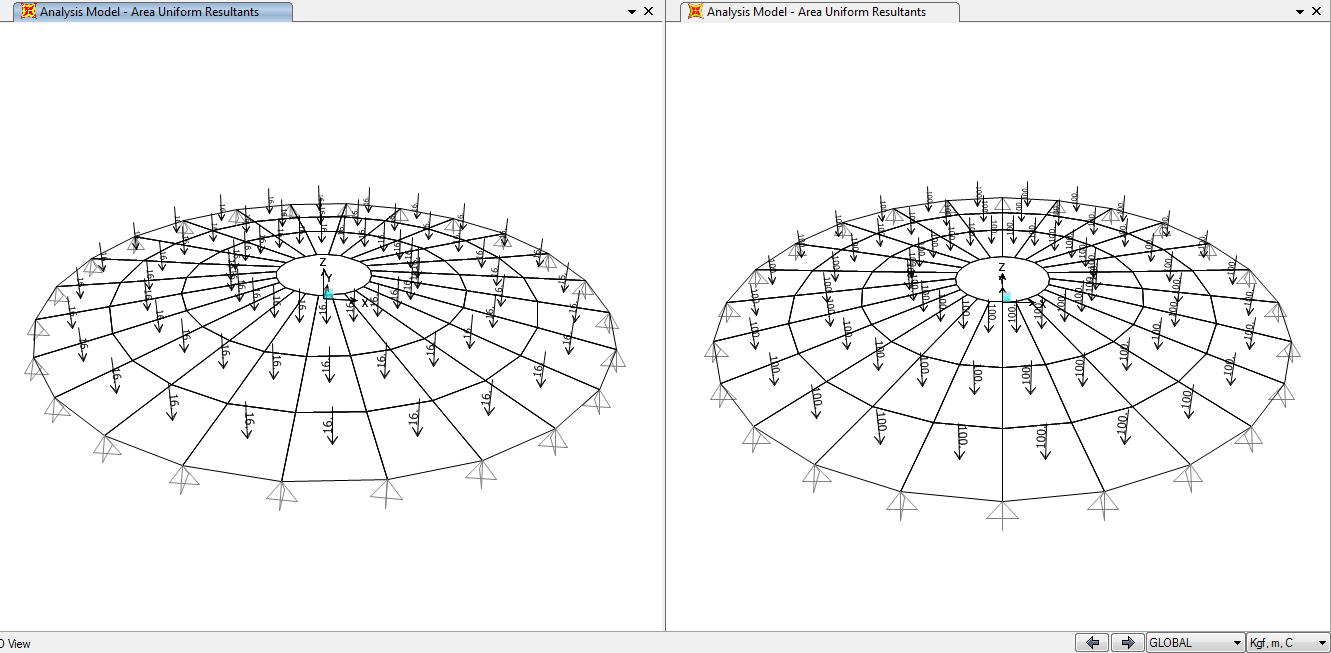
Table: Mass Source

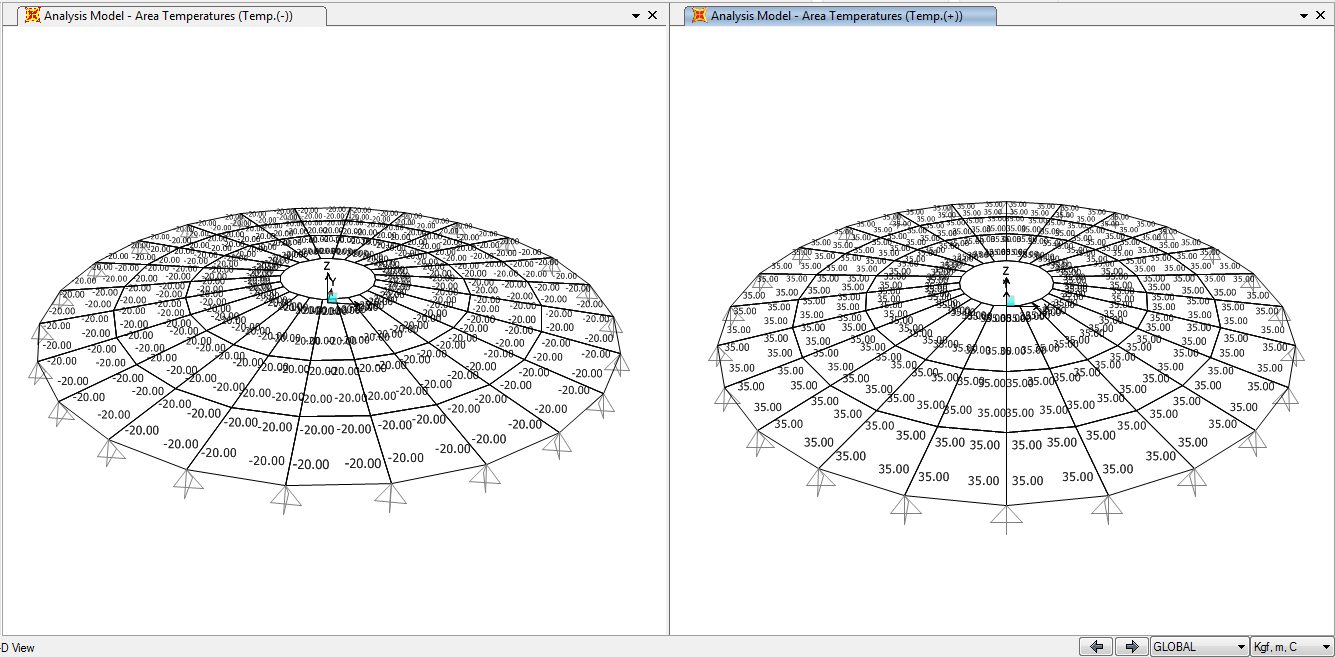
| Table: Mass Source | | | | | | |
| --- | --- | --- | --- | --- | --- | --- |
| MassSource | Elements | Masses | Loads | IsDefault | LoadPat | Multiplier |
|  |  |  |  |  |  |  |
| MSSSRC1 | No | No | Yes | Yes | DEAD | 1. |
| MSSSRC1 |  |  |  |  | LL | 0.4 |

Table: Combination Definitions,

|  |  | | Table: Combination Definitions | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Combo  Name | | Combo  Type | | Auto  Design | | Case  Type | Case  Name | | Scale  Factor | Steel  Design | Notes |
|  | |  | |  | |  |  | |  |  |  |
| UDSTL1 | | Linear Add | | No | | Linear Static | DEAD | | 1.4 | Strength | Dead Only; Strength |
| UDSTL2 | | Linear Add | | No | | Linear Static | DEAD | | 1.2 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL2 | |  | |  | | Linear Static | LIVE | | 1.6 |  |  |
| UDSTL2 | |  | |  | | Linear Static | LL(asymmetric) | | 0.5 |  |  |
| UDSTL3 | | Linear Add | | No | | Linear Static | DEAD | | 1.2 | Strength | Dead + Live + Snow; Strength |
| UDSTL3 | |  | |  | | Linear Static | LL(asymmetric) | | 1.6 |  |  |
| UDSTL3 | |  | |  | | Linear Static | LIVE | | 1. |  |  |
| UDSTL4 | | Linear Add | | No | | Linear Static | DEAD | | 1.2 | Strength |  |
| UDSTL4 | |  | |  | | Linear Static | LL(asymmetric) | | 1.6 |  |  |
| UDSTL4 | |  | |  | | Linear Static | WIND | | 0.8 |  |  |
| UDSTL5 | | Linear Add | | No | | Linear Static | DEAD | | 1.2 | Strength |  |
| UDSTL5 | |  | |  | | Linear Static | LL(asymmetric) | | 0.5 |  |  |
| UDSTL5 | |  | |  | | Linear Static | WIND | | 1.6 |  |  |
| UDSTL5 | |  | |  | | Linear Static | LIVE | | 1. |  |  |
| UDSTL9 | | Linear Add | | No | | Linear Static | DEAD | | 1.2 | Strength | Dead (min) - Wind; Strength |
| UDSTL9 | |  | |  | | Linear Static | EQ | | -1. |  |  |
| UDSTL9 | |  | |  | | Linear Static | LIVE | | 1. |  |  |
| UDSTL9 | |  | |  | Linear Static | | EQ(V) | | 1. |  |  |
| UDSTL8 | | Linear Add | | No | Linear Static | | DEAD | | 0.9 | Strength | Dead + Live + Static Earthquake; Strength |
| UDSTL8 | |  | |  | Linear Static | | EQ | | 1. |  |  |
| UDSTL8 | |  | |  | Linear Static | | EQ(V) | | 1. |  |  |
| UDSTL6 | | Linear Add | | No | Linear Static | | DEAD | | 1.2 | Strength | Dead + Live - Static Earthquake; Strength |
| UDSTL6 | |  | |  | Linear Static | | LL(asymmetric) | | 0.2 |  |  |
| UDSTL6 | |  | |  | Linear Static | | EQ | | 1. |  |  |
| UDSTL6 | |  | |  | Linear Static | | EQ(V) | | 1. |  |  |
| UDSTL6 | |  | |  | Linear Static | | LIVE | | 1. |  |  |
| UDSTL7 | | Linear Add | | No | Linear Static | | DEAD | | 0.9 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL7 | |  | |  | Linear Static | | WIND | | 1.6 |  |  |
| UDSTL10 | | Linear Add | | No | Linear Static | | DEAD | | 1.2 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL10 | |  | |  | Linear Static | | LIVE | | 1.6 |  |  |
| UDSTL10 | |  | |  | Linear Static | | Temp.(+) | | 1. |  |  |
| UDSTL10 | |  | |  | Linear Static | | LL(asymmetric) | | 1.6 |  |  |
| UDSTL11 | | Linear Add | | No | Linear Static | | DEAD | | 1.2 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL11 | |  | |  | Linear Static | | LIVE | | 0.5 |  |  |
| UDSTL11 | |  | |  | Linear Static | | Temp.(-) | | 1.2 |  |  |
| UDSTL11 | |  | |  | Linear Static | | LL(asymmetric) | | 0.5 |  |  |
| UDSTL12 | | Linear Add | | No | Linear Static | | DEAD | | 1.2 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL12 | |  | |  | Linear Static | | LIVE | | 1.6 |  |  |
| UDSTL12 | |  | |  | Linear Static | | Temp.(-) | | 1. |  |  |
| UDSTL12 | |  | |  | Linear Static | | LL(asymmetric) | | 1.6 |  |  |
| UDSTL13 | | Linear Add | | No | Linear Static | | DEAD | | 1.2 | Strength | Dead + Live + Snow (Partial); Strength |
| UDSTL13 | |  | |  | Linear Static | | LIVE | | 0.5 |  |  |
| UDSTL13 | |  | |  | Linear Static | | Temp.(+) | | 1.2 |  |  |
| UDSTL13 | |  | |  | Linear Static | | LL(asymmetric) | | 0.5 |  |  |







1. ***STRUCTURE DESIGN:***

# DESIGN:

Steel structure design has performed according to AISC-360-10 by SAP2000 program.

# Input Design Data:

1. **K-Value (Effective Length Factor)**

K-Value used for determining column slenderness. K-Value of columns and rafters for braced frame direction has taken 1.0.

# Out Put Design Data:

Table: Steel Design 1 - Summary Data - AISC 360-10

|  |  | |  | |  | | Table: Steel Design 1 - Summary Data - AISC 360-10, | | | | | |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Frame | | Design  Sect | | Design  Type | | Status | | Ratio | Ratio  Type | Combo | Location | ErrMsg | | WarnMsg |
|  | |  | |  | |  | |  |  |  | m |  | |  |
| 26 | | B1 | | Beam | | No Messages | | 0.272933 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 27 | | B1 | | Beam | | No Messages | | 0.274187 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 28 | | B1 | | Beam | | No Messages | | 0.275995 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 29 | | B1 | | Beam | | No Messages | | 0.277941 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 30 | | B1 | | Beam | | No Messages | | 0.280494 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 31 | | B1 | | Beam | | No Messages | | 0.281632 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 32 | | B1 | | Beam | | No Messages | | 0.280021 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 33 | | B1 | | Beam | | No Messages | | 0.274572 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 34 | | B1 | | Beam | | No Messages | | 0.266473 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 35 | | B1 | | Beam | | No Messages | | 0.261601 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 36 | | B1 | | Beam | | No Messages | | 0.259172 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 37 | | B1 | | Beam | | No Messages | | 0.257872 | PMM | UDSTL10 | 0. | No Messages | | No Messages |
| 38 | | B1 | | Beam | | No Messages | | 0.257872 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 39 | | B1 | | Beam | | No Messages | | 0.259172 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 40 | | B1 | | Beam | | No Messages | | 0.261601 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 41 | | B1 | | Beam | | No Messages | | 0.266473 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 42 | | B1 | | Beam | | No Messages | | 0.274572 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 43 | | B1 | | Beam | | No Messages | | 0.280021 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 44 | | B1 | | Beam | | No Messages | | 0.281632 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 45 | | B1 | | Beam | | No Messages | | 0.280494 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 46 | | B1 | | Beam | | No Messages | | 0.277941 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 47 | | B1 | | Beam | | No Messages | | 0.275995 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 48 | | B1 | | Beam | | No Messages | | 0.274187 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 49 | | B1 | | Beam | | No Messages | | 0.272933 | PMM | UDSTL10 | 0.28716 | No Messages | | No Messages |
| 50 | | IPE160 | | Brace | | No Messages | | 0.769684 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 51 | | IPE160 | | Brace | | No Messages | | 0.761548 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 52 | | IPE160 | | Brace | | No Messages | | 0.76079 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 53 | | IPE160 | | Brace | | No Messages | | 0.761548 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 54 | | IPE160 | | Brace | | No Messages | | 0.769684 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 55 | | IPE160 | | Brace | | No Messages | | 0.772581 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 56 | | IPE160 | | Brace | | No Messages | | 0.776484 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 57 | | IPE160 | | Brace | | No Messages | | 0.78144 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 58 | | IPE160 | | Brace | | No Messages | | 0.787326 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 59 | | IPE160 | | Brace | | No Messages | | 0.794203 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 60 | | IPE160 | | Brace | | No Messages | | 0.830167 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 61 | | IPE160 | | Brace | | No Messages | | 0.835568 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 62 | | IPE160 | | Brace | | No Messages | | 0.839369 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 63 | | IPE160 | | Brace | | No Messages | | 0.813101 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 64 | | IPE160 | | Brace | | No Messages | | 0.812935 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 65 | | IPE160 | | Brace | | No Messages | | 0.813101 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 66 | | IPE160 | | Brace | | No Messages | | 0.839369 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 67 | | IPE160 | | Brace | | No Messages | | 0.835568 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 68 | | IPE160 | | Brace | | No Messages | | 0.830167 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 69 | | IPE160 | | Brace | | No Messages | | 0.794203 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 70 | | IPE160 | | Brace | | No Messages | | 0.787326 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 71 | | IPE160 | | Brace | | No Messages | | 0.78144 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 72 | | IPE160 | | Brace | | No Messages | | 0.776484 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 73 | | IPE160 | | Brace | | No Messages | | 0.772581 | PMM | UDSTL12 | 1.63169 | No Messages | | No Messages |
| 9 | | L80X8 | | Beam | | No Messages | | 0.493249 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 10 | | L80X8 | | Beam | | No Messages | | 0.495601 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 11 | | L80X8 | | Beam | | No Messages | | 0.498572 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 12 | | L80X8 | | Beam | | No Messages | | 0.502017 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 13 | | L80X8 | | Beam | | No Messages | | 0.50576 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 14 | | L80X8 | | Beam | | No Messages | | 0.509573 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 15 | | L80X8 | | Beam | | No Messages | | 0.513089 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 16 | | L80X8 | | Beam | | No Messages | | 0.51595 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 17 | | L80X8 | | Beam | | No Messages | | 0.51796 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 18 | | L80X8 | | Beam | | No Messages | | 0.518998 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 19 | | L80X8 | | Beam | | No Messages | | 0.518998 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 20 | | L80X8 | | Beam | | No Messages | | 0.51796 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 21 | | L80X8 | | Beam | | No Messages | | 0.51595 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 22 | | L80X8 | | Beam | | No Messages | | 0.513089 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 23 | | L80X8 | | Beam | | No Messages | | 0.509573 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 24 | | L80X8 | | Beam | | No Messages | | 0.50576 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 25 | | L80X8 | | Beam | | No Messages | | 0.502017 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 74 | | L80X8 | | Beam | | No Messages | | 0.498572 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 75 | | L80X8 | | Beam | | No Messages | | 0.495601 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 76 | | L80X8 | | Beam | | No Messages | | 0.493249 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 77 | | L80X8 | | Beam | | No Messages | | 0.491622 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 78 | | L80X8 | | Beam | | No Messages | | 0.490791 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 79 | | L80X8 | | Beam | | No Messages | | 0.490791 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 80 | | L80X8 | | Beam | | No Messages | | 0.491622 | PMM | UDSTL10 | 0.42552 | No Messages | | No Messages |
| 81 | | L80X8 | | Beam | | No Messages | | 0.588918 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 82 | | L80X8 | | Beam | | No Messages | | 0.590814 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 83 | | L80X8 | | Beam | | No Messages | | 0.593291 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 84 | | L80X8 | | Beam | | No Messages | | 0.59631 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 85 | | L80X8 | | Beam | | No Messages | | 0.599821 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 86 | | L80X8 | | Beam | | No Messages | | 0.603794 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 87 | | L80X8 | | Beam | | No Messages | | 0.607547 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 88 | | L80X8 | | Beam | | No Messages | | 0.610398 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 89 | | L80X8 | | Beam | | No Messages | | 0.612327 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 90 | | L80X8 | | Beam | | No Messages | | 0.613299 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 91 | | L80X8 | | Beam | | No Messages | | 0.613299 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 92 | | L80X8 | | Beam | | No Messages | | 0.612327 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 93 | | L80X8 | | Beam | | No Messages | | 0.610398 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 94 | | L80X8 | | Beam | | No Messages | | 0.607547 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 95 | | L80X8 | | Beam | | No Messages | | 0.603794 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 96 | | L80X8 | | Beam | | No Messages | | 0.599821 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 97 | | L80X8 | | Beam | | No Messages | | 0.59631 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 98 | | L80X8 | | Beam | | No Messages | | 0.593291 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 99 | | L80X8 | | Beam | | No Messages | | 0.590814 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 100 | | L80X8 | | Beam | | No Messages | | 0.588918 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 101 | | L80X8 | | Beam | | No Messages | | 0.587636 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 102 | | L80X8 | | Beam | | No Messages | | 0.586989 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 103 | | L80X8 | | Beam | | No Messages | | 0.586989 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |
| 104 | | L80X8 | | Beam | | No Messages | | 0.587636 | PMM | UDSTL10 | 0.42465 | No Messages | | No Messages |

# 

# 

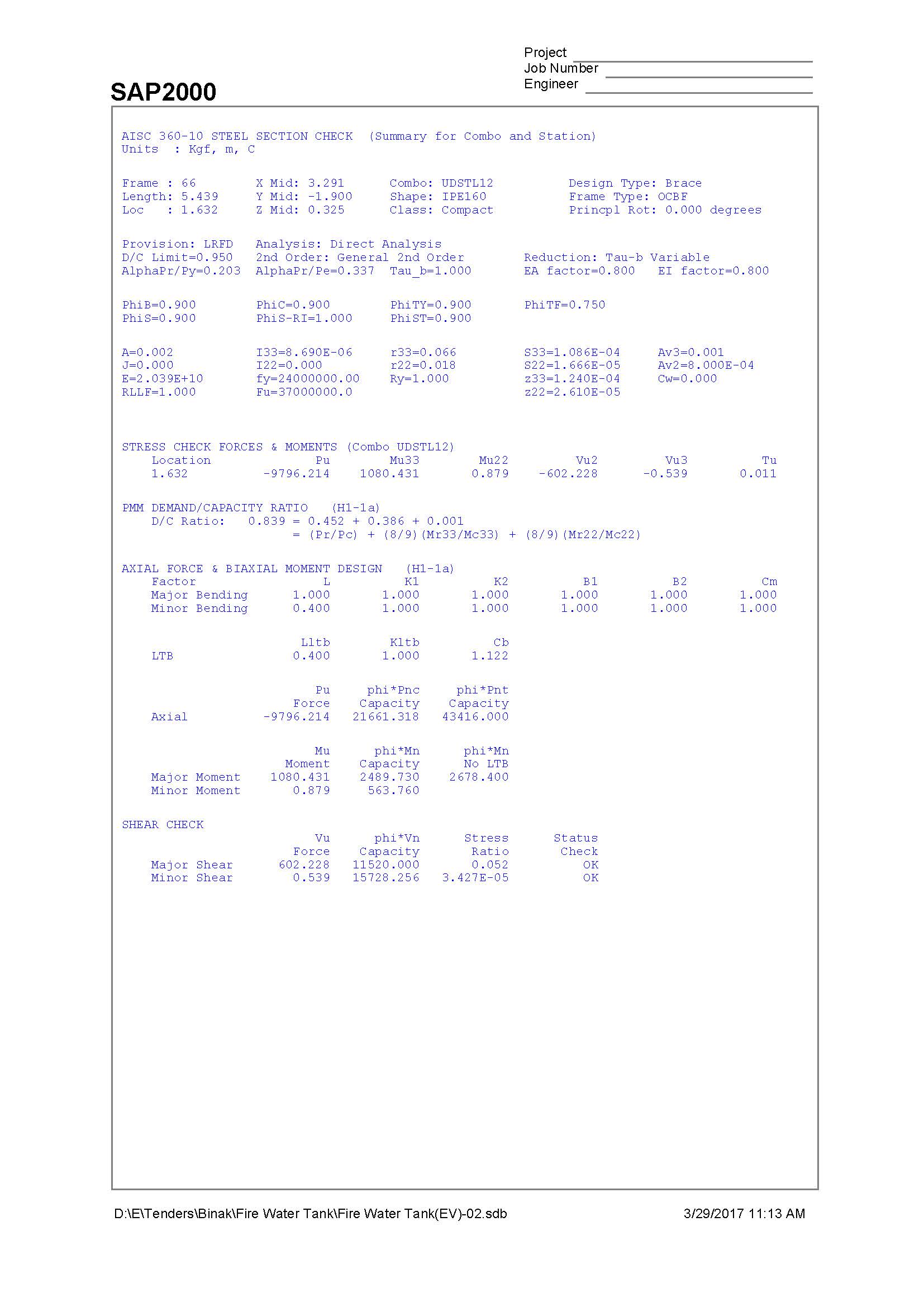
**Deflection Control**

For Dead + Live case the deflection must be <=L/240 (UBC-97, Table16-D) so Maximum

deflection is equal to 22 mm (5500/240=22 mm). With sap analysis maximum

deflection 13 millimeter was obtained for DEFLECTION load case (DEAD + LIVE).

# 

Main Rafter Design Example: 

Lateral Beam Design Example:

