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| **طرح نگهداشت و افزایش تولید 27 مخزن** | | | | | | |
| **CALCULATION NOTE FOR CCTV RACK ROOM- BINAK PU**  **نگهداشت و افزایش تولید میدان نفتی بینک** | | | | | | |
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| D02 | | FEB. 2024 | AFD | R.Berlouie | M.Fakharian | S.Faramarzpour |  |
| D01 | | JAN. 2024 | IFA | R.Berlouie | M.Fakharian | S.Faramarzpour |  |
| D00 | | OCT. 2023 | IFC | R.Berlouie | M.Fakharian | S.Faramarzpour |  |
| **Rev.** | | **Date** | **Purpose of Issue/Status** | **Prepared by:** | **Checked by:** | **Approved by:** | **CLIENT Approval** |
| **Class:2** | | | **COMPANY Doc. Number:** **F0Z-709401** | | | | |
| **Status:** | | **IDC: Inter-Discipline Check**  **IFC: Issued For Comment**  **IFA: Issued For Approval**  **AFD: Approved For Design**  **AFC: Approved For Construction**  **AFP: Approved For Purchase**  **AFQ:** Approved For Quotation  **IFI: Issued For Information**  **AB-R: As-Built for CLIENT Review**  **AB-A: As-Built –Approved** | | | | | |

**REVISION RECORD SHEET**

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| **32** |  |  |  |  |  | **97** |  |  |  |  |  |
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| **34** |  |  |  |  |  | **99** |  |  |  |  |  |
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| **36** |  |  |  |  |  | **101** |  |  |  |  |  |
| **37** |  |  |  |  |  | **102** |  |  |  |  |  |
| **38** |  |  |  |  |  | **103** |  |  |  |  |  |
| **39** |  |  |  |  |  | **104** |  |  |  |  |  |
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| **43** |  |  |  |  |  | **108** |  |  |  |  |  |
| **44** |  |  |  |  |  | **109** |  |  |  |  |  |
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| **49** |  |  |  |  |  | **114** |  |  |  |  |  |
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| **51** |  |  |  |  |  | **116** |  |  |  |  |  |
| **52** |  |  |  |  |  | **117** |  |  |  |  |  |
| **53** |  |  |  |  |  | **118** |  |  |  |  |  |
| **54** |  |  |  |  |  | **119** |  |  |  |  |  |
| **55** |  |  |  |  |  | **120** |  |  |  |  |  |
| **56** |  |  |  |  |  | **121** |  |  |  |  |  |
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| **60** |  |  |  |  |  | **125** |  |  |  |  |  |
| **61** |  |  |  |  |  | **126** |  |  |  |  |  |
| **62** |  |  |  |  |  | **127** |  |  |  |  |  |
| **63** |  |  |  |  |  | **128** |  |  |  |  |  |
| **64** |  |  |  |  |  | **129** |  |  |  |  |  |
| **65** |  |  |  |  |  | **130** |  |  |  |  |  |

**CONTENTS**

[1.0 INTRODUCTION 5](#_Toc156726633)

[2.0 Scope 6](#_Toc156726634)

[3.0 NORMATIVE REFERENCES 6](#_Toc156726635)

[3.1 Local Codes and Standards 6](#_Toc156726636)

[3.2 International Codes and Standards 6](#_Toc156726637)

[3.3 The Project Documents 6](#_Toc156726638)

[3.4 Order of Precedence 7](#_Toc156726639)

[4.0 Material properties 7](#_Toc156726640)

[5.0 Computer software 7](#_Toc156726641)

[6.0 DESIGN INFORMATION 7](#_Toc156726642)

[6.1 Structure Location 7](#_Toc156726643)

[6.2 Architectural Plans 8](#_Toc156726644)

[7.0 material properties 9](#_Toc156726645)

[7.1 Reinforced Concrete 9](#_Toc156726646)

[7.2 Stiffness Modification 9](#_Toc156726647)

[8.0 design loads 9](#_Toc156726648)

[8.1 General 9](#_Toc156726649)

[9.0 Dead Load 10](#_Toc156726650)

[10.0 Live Load 12](#_Toc156726651)

[11.0 Snow Load 13](#_Toc156726652)

[12.0 Seismic Load 14](#_Toc156726653)

[12.1 Horizontal Seismic Load 14](#_Toc156726654)

[12.2 Vertical seismic load 15](#_Toc156726655)

[13.0 Redundancy Factor 16](#_Toc156726656)

[14.0 loading table 17](#_Toc156726657)

[15.0 Load combinations 18](#_Toc156726658)

[16.0 STRUCTURE ANALYSIS AND DESIGN 20](#_Toc156726659)

[17.0 Structural Design Results 21](#_Toc156726660)

[18.0 DRIFT CONTROL 22](#_Toc156726661)

[19.0 Joist shear capacity ratio CONTROL 23](#_Toc156726662)

[20.0 Strong Column-Weak Beam Requirements in SPECIAL CONCRETE Moment Frame 23](#_Toc156726664)

[21.0 FOUNDATION DESIGN AND RESULTS 24](#_Toc156726665)

[21.1 Foundation Model 24](#_Toc156726677)

[21.2 Soil cHARACTERISTIC 24](#_Toc156726678)

[21.3 Loads 26](#_Toc156726679)

[21.4 Settlement Control 26](#_Toc156726680)

[21.5 Soil pressure control 27](#_Toc156726681)

[21.6 Punching Shear Control 28](#_Toc156726682)

[21.7 Foundation Design 28](#_Toc156726683)

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.

As a part of the Project, a New Gas Compressor Station (adjacent to existing Binak GCS) shall be constructed to gather of 15 MMSCFD (approx.) associated gases and compress & transfer them to Siahmakan GIS.

**GENERAL DEFINITION**

The following terms shall be used in this document.

|  |  |
| --- | --- |
| CLIENT: | National Iranian South Oilfields Company (NISOC) |
| PROJECT: | Binak Oilfield Development – Surface Fcilities; New Gas Compressor Station |
| EPD/EPC CONTRACTOR (GC): | Petro Iran Development Company (PEDCO) |
| EPC CONTRACTOR: | Joint Venture of : Hirgan Energy – Design & Inspection (D&I) Companies |
| VENDOR: | The firm or person who will fabricate the equipment or material. |
| EXECUTOR: | Executor is the party which carries out all or part of construction and/or commissioning for the project. |
| THIRD PARTY INSPECTOR (TPI): | The firm appointed by EPD/EPC CONTRACTOR (GC) and approved by CLIENT (in writing) for the inspection of goods. |
| 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. **Scope**

This report covers designing of structure & foundation of the “CCTV Control Room- Binak PU”. The structure calculation is performed by “ETABS” & calculation of foundation is performed by “SAFE” software’s.

1. **NORMATIVE REFERENCES**

## Local Codes and Standards

* INBC Part 6 “Iranian National Building Code
* INBC Part 7 “Iranian National Building Code
* INBC Part 9 “Iranian National Building Code
* INBC Part 10 “Iranian National Building Code
* Iranian Seismic Design Code for Petroleum Facilities(3rd edition)

## International Codes and Standards

* ASCE 7-10 “Minimum Design Loads and Associated Criteria for Buildings and Other Structures-American Society of Civil Engineers”.
* ACI 318 “Building Code Requirements for Reinforced Concrete”, American Concrete Institute.
* AISC 358 “Prequalified Connections for Special and Intermediate Steel Moment Frames for Seismic Applications.” American Institute of Steel Construction, Inc.
* AISC 360 “Specification for Structural Steel Buildings”. American Institute of Steel Construction, Inc.

## The Project Documents

* BK-GNRAL-PEDCO-000-ST-SP-0001 Specification for Concrete Work
* BK-GNRAL-PEDCO-000-ST-DC-0001 Structural Design Criteria
* BK-GNRAL-PEDCO-000-CV-SP-0004 Specification for Earth Work
* BK-GCS-PEDCO-120-GT-RT-0001 Geotechnical Investigation Report for Compressor Station
* BK-GCS-PEDCO-120-AR-DW-0010 Architectural Drawing for CCTV Rack Room- Binak PU

## Order of Precedence

In case of any conflict between the contents of this document or any discrepancy between this document and other project documents or reference standards, this issue must be reported to the CLIENT. The final decision in this situation will be made by CLIENT.

1. **Material properties**

Material properties are delivered in the following table.

|  |  |
| --- | --- |
| Material properties | |
| Structure and Foundation concrete | F’c=300 kg/cm² (28 days cylindrical sample) |
| Long. Reinforcement | Fy=4000 kg/cm² (AIII) |
| Trans. Reinforcement | Fy=4000 kg/cm² (AIII) |

1. **Computer software**

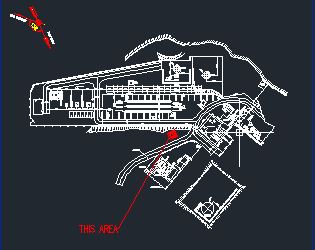
Computer’s Software, which is used in structure and foundation analysis and design, are defined in the following table.

|  |  |
| --- | --- |
| Computer software | |
| analysis and design of structure | ETABS 16.2.1 |
| analysis and design of foundation | SAFE 16.0.2 |

1. **DESIGN INFORMATION**

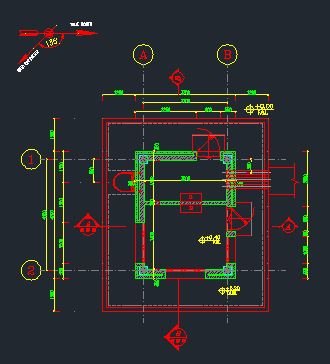
## Structure Location

The CCTV control room is located in Binak oilfield.

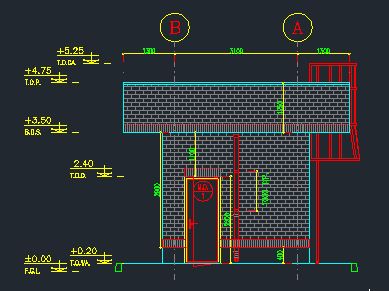


**Figure 1: Project Location**

## Architectural Plans



**Figure 2: Plan of CCTV control room-PU**



**Figure 3: Elevation 1**

1. **material properties**

## Reinforced Concrete

Concrete shall generally conform to the specification for Concrete Work, Document No: BK-GNRAL-PEDCO-000-ST-SP-0001. The following properties of concrete are used.

Lean concrete: f’c =150 kg/cm2

Cast in place concrete: f’c =300 kg/cm2

Where f'c is the minimum compressive characteristic strength of a cylinder specimen at 28 days.

Young Modulus of concrete: kg/cm2 =261540 kg/cm2

Poisson's Ratio: ν = 0.2

Unit weight of reinforced concrete: 2500 kg/m3

Reinforcing Steel: fy = 4000 kg/cm3 (Minimum yield stress)

## Stiffness Modification

For analysis of concrete structure, the following modifications for flexural stiffness of elements are considered.

Columns………………………………..0.7Ig

Beams………………………………….0.35Ig

1. **design loads**

## General

Structural elements stability and stress checking have been performed considering the following load conditions.

* Dead Load
* Live Load
* Seismic Load
* Snow Load

1. **Dead Load**

Dead Load is considered as the weight of materials forming a permanent part of the structure plant. The weight of materials of construction incorporated into the building, including but not limited to walls, floors, roofs, ceilings, stairways, built-in partitions, finishes, cladding and other similarly incorporated architectural and structural items, and the weight of fixed service equipment, such as plumbing stacks and risers, electrical feeders, heating, ventilating and air-conditioning systems.

Specific weight of materials which will be used is based on Iranian National Building Code, Part 6, where applicable. Other weights are in accordance with the specifications and/or drawings of vendors and manufacturers.

As it mentioned above the self-weight of structural elements (introduced Dead Load in software) is automatically considered by ETABS program with the specific weights below:

Reinforced Concrete: 2500 kg/m³

Structural Steel and Bars: 7850 kg/m³

Here is the calculation of design dead load for floors and walls.

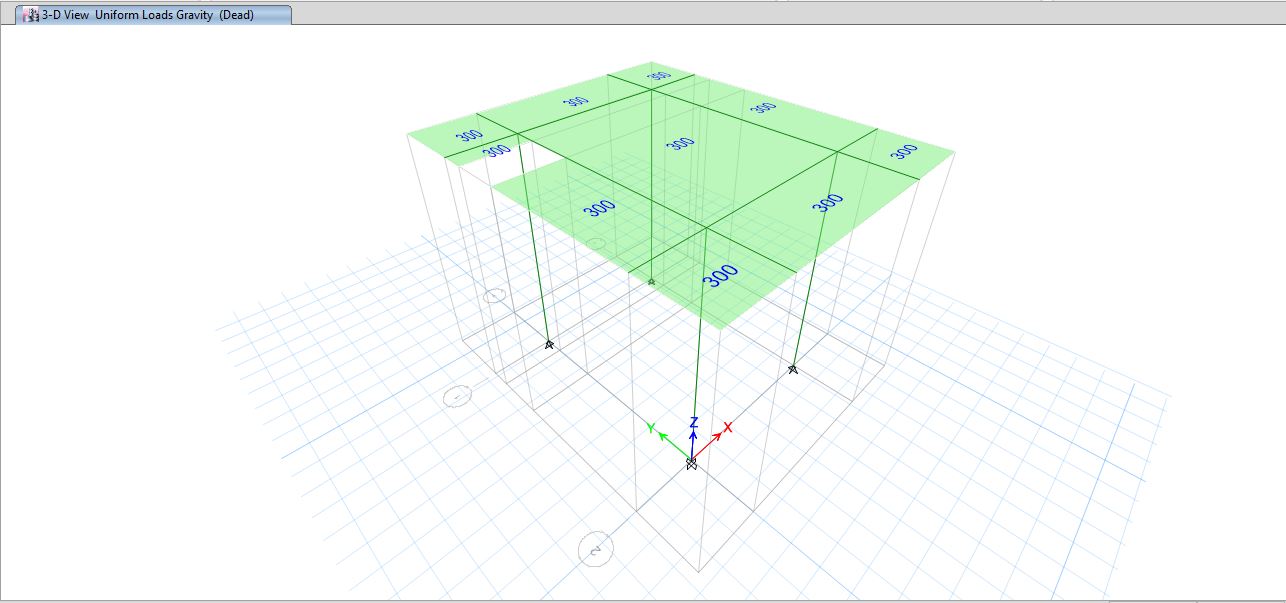
(Pressed brick = 20cm 1700 = 340→340 = 408 kg/m) + (Travertine stone= 2500 2cm = 50→50 1.2 = 60 kg/m) + (mortar = 1cm 2100 = 21 → 21 1.2 = 25.2 kg/m) + (Terrazzo tile (30\*30\*2.5)= 2500 2cm = 50→50 0.3 = 15 kg/m) + (mortar = 1cm 2100 = 21 → 21 0.3 = 6.3 kg/m) + (cement = 3cm = 63→63 1 = 63 kg/m) + (Waterproofing (Isolation or Similar = 15 kg/m² 30cm =4.5 kg/m) → totally ≈ 585 kg/m

* ) :

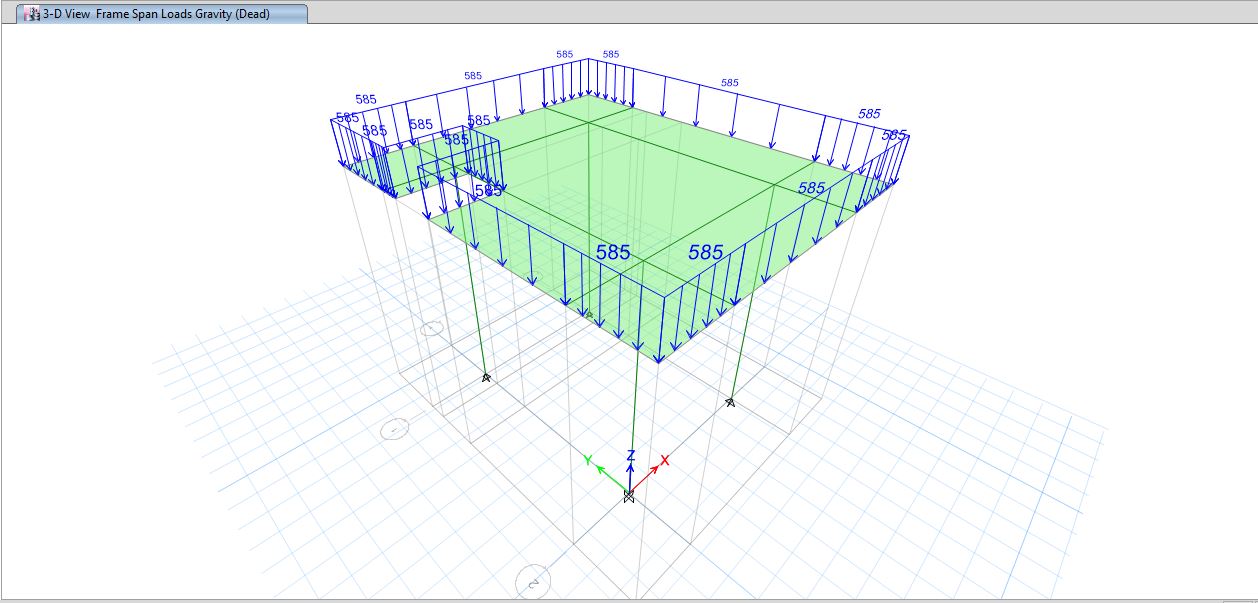
(Face Brick = 5cm 1700 = 85) + (Pressed brick = 20cm 1700 = 340) + (plaster and soil mortar = 3cm 1600 = 48) → totally ≈ 475 kg/m²



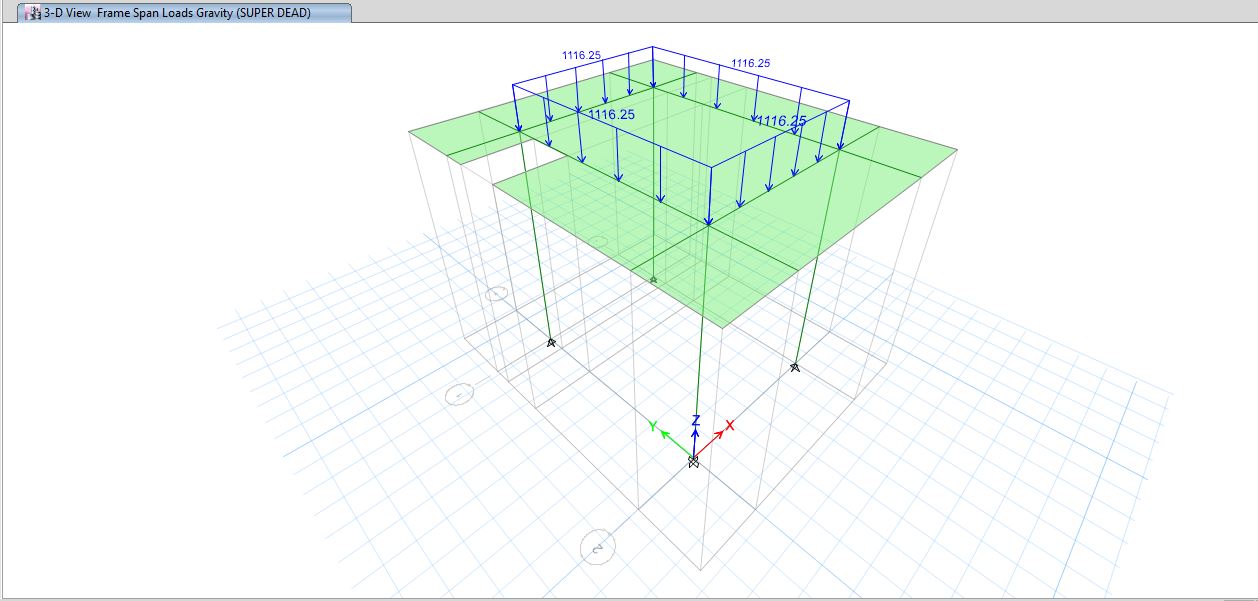
) + (clay block = 8 10 = 80) + (facilities = 20) + (waterproofing = 15) → totally ≈ 300 kg/m²



**Figure 4: Dead load on roof**



**Figure 5: Parapet dead load**



**Figure 6: Dead load for wall**

1. **Live Load**

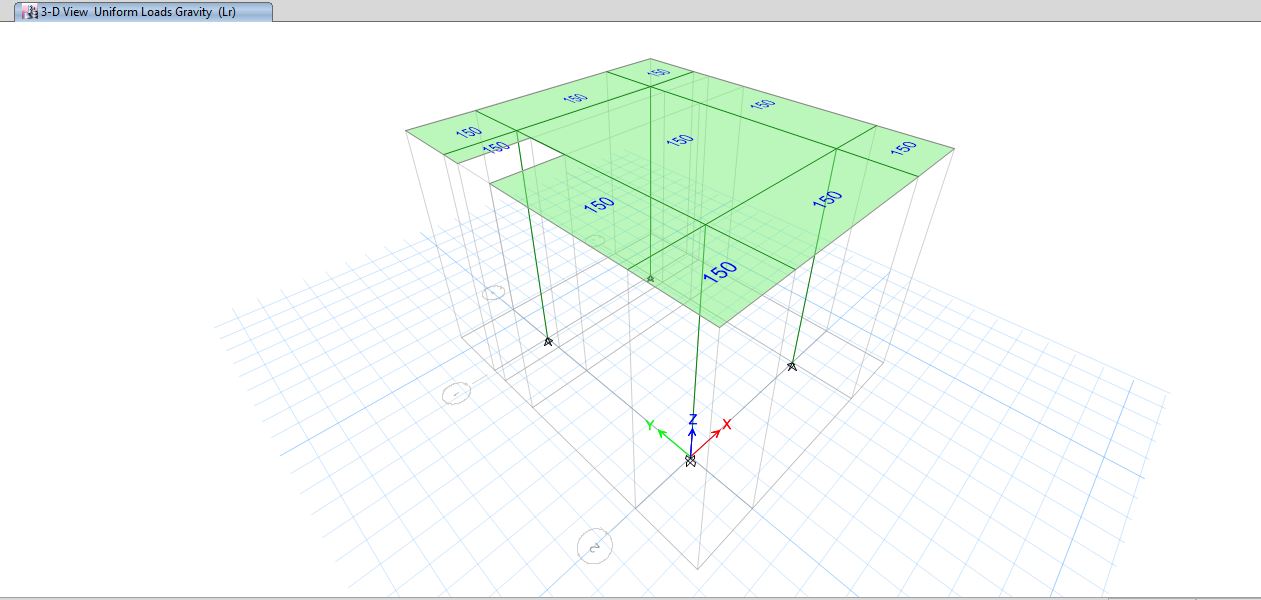
Live Load is defined as the weight of all movable loads, including partition walls, personnel, tools, miscellaneous equipment and temporarily stored materials.

Generally where applicable, the live loads shall be in accordance with Iranian National Building Code, Part 6. The Live Loads is generally considered as uniformly distributed over the horizontal projection of the loaded areas, except for the loads with a concentrated nature.

The live load has been considered according to the following table.

**Table 1- Live Load**

|  |  |  |
| --- | --- | --- |
| NO. | Level | kg/m2 |
| 1 | Roof | 150 |

****

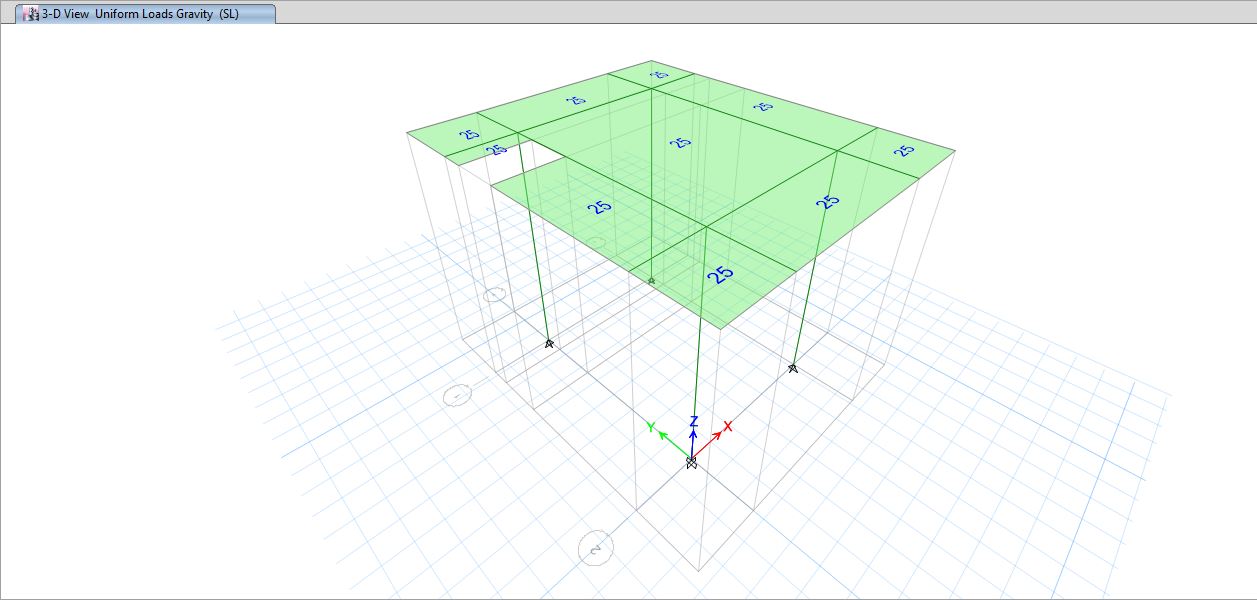
**Figure 7: Live load on roof**

1. **Snow Load**

Snow load of this structure is calculated in accordance with Iranian National Building Code No.6 Latest edition. Parameters which are used in calculation of snow force is presented in below:

Pr=Is.Cn.Ch.Cs.Ps Ps=25 kg/m2

Is=1, Cn= 1, Ch= 1, Cs= 1 → Pr=Ps = 25 kg/m2



**Figure 8: Snow load on roof**

1. **Seismic Load**

## Horizontal Seismic Load

According to Iranian Seismic Design Code for Petroleum Facilities (Pub.038-3rd edition) the structure shall be designed for earthquake load in two orthogonal directions.

Base level is defined as the level below which the structure does not move relative to the ground during an earthquake.

Basic parameters which are used in calculation of earthquake forces are presented below.

Following formula is used for calculations according to Iranian Seismic Design Code for Petroleum Facilities (Pub.038-3rd edition)

In which:

: Basic Shear

Sa: Mapped Spectral Response Acceleration Parameter (𝑔)

I: Importance Factor of Structure

Ru: Structural System Factor

W= Effective Seismic Weight of the structure, including dead loads and other loads, calculated from base level.

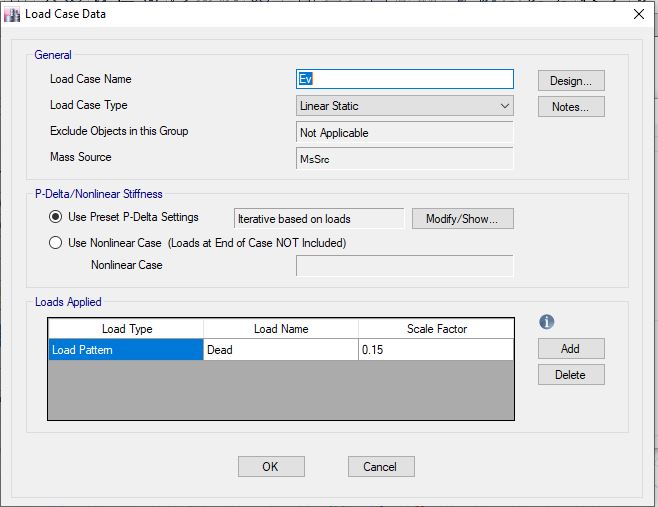
**Table 6- Basic Parameters Used for Earthquake Loads**

|  |  |
| --- | --- |
| Height of the structure from the base level (m) | 4.70 |
| Importance factor, I | 1.25 |
| Structural System | Special Moment Frame at Both Direction |
| Soil type | II |
| Ru | 8 |
| (Based on table (4-6) Pub.038) | 0.047 |
| X (Based on table (4-6) Pub.038) | 0.9 |
|  | 0.189 |
| Based on part (4-8-3) Pub.038 : | = 0.189\*1.4 = 0.265 |
| (analysis) – mode 2 | 0.477 |
| (analysis) – mode 3 | 0.463 |
|  | 0.265 |
|  | 0.265 |
|  | 0.75 |
|  | 0.75 |
|  | 0.04125 |
|  | 0.117 |
|  | 0.117 |



## Vertical seismic load

Ev: Vertical seismic load applied at model according to section 2-2-3-2 (code 038)



1. **Redundancy Factor**

According to Iranian Seismic Design Code for Petroleum Facilities (Pub.038-3rd edition Paragraph 4-6) - =1.0

1. **loading table**

Loading for structure and foundation for CCTV control room is defined as below table.

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **TABLE** | | | | | | |
| **Load Pat** | **Design Type** | **Self Wt Mult** | **Auto Load** | **Not Base Pat** | **Not Ratio** | **Not Dir.** |
| DL | Dead | 1 |  |  |  |  |
| Lr | Roof Live | 0 |  |  |  |  |
| EX | Quake | 0 | USER COEFF |  |  |  |
| EY | Quake | 0 | USER COEFF |  |  |  |
| SL | Snow | 0 |  |  |  |  |
| SUPERDEAD | Dead | 0 |  |  |  |  |
| T | Temperature | 0 |  |  |  |  |
| Ev | Quake | 0 | None |  |  |  |
| NotionalX(DL) | Notional | 0 |  | DL | 0.002 | Global X |
| NotionalY(DL) | Notional | 0 |  | DL | 0.002 | Global Y |
| NotionalX(Lr) | Notional | 0 |  | Lr | 0.002 | Global X |
| NotionalY(Lr) | Notional | 0 |  | Lr | 0.002 | Global Y |
| NotionalX (SUPERDEAD) | Notional | 0 |  | SUPERDEAD | 0.002 | Global X |
| NotionalY (SUPERDEAD) | Notional | 0 |  | SUPERDEAD | 0.002 | Global Y |
| Soil | Other | 0 |  |  |  |  |

Notional loads must be added with the same coefficient in all combinations of loads that have gravity loads. Although this type is not necessary for concrete building, it has been considered.

1. **Load combinations**

For foundations, structures and members of structures, according to structural design criteria & Iranian National Building Code Part 6, the following load combinations have been considered:

1) 1.4D

2) 1.2D + 1.6L + 0.5 (Lr or S)

3) 1.2D + 1.6 (Lr or S) + (L or 0.5(1.6W))

4) 1.2D +1.6 W + L + 0.5 (Lr or S)

5) 1.2D+(Eh + Ev)+ L + 0.2S

6) 0.9D + 1.6W

7) 0.9D + (Eh – Ev)

Load listed herein shall be considered to act in the following combinations; whichever produces the most unfavourable effect considering soil reactions.

**Allowable Stress Design:**

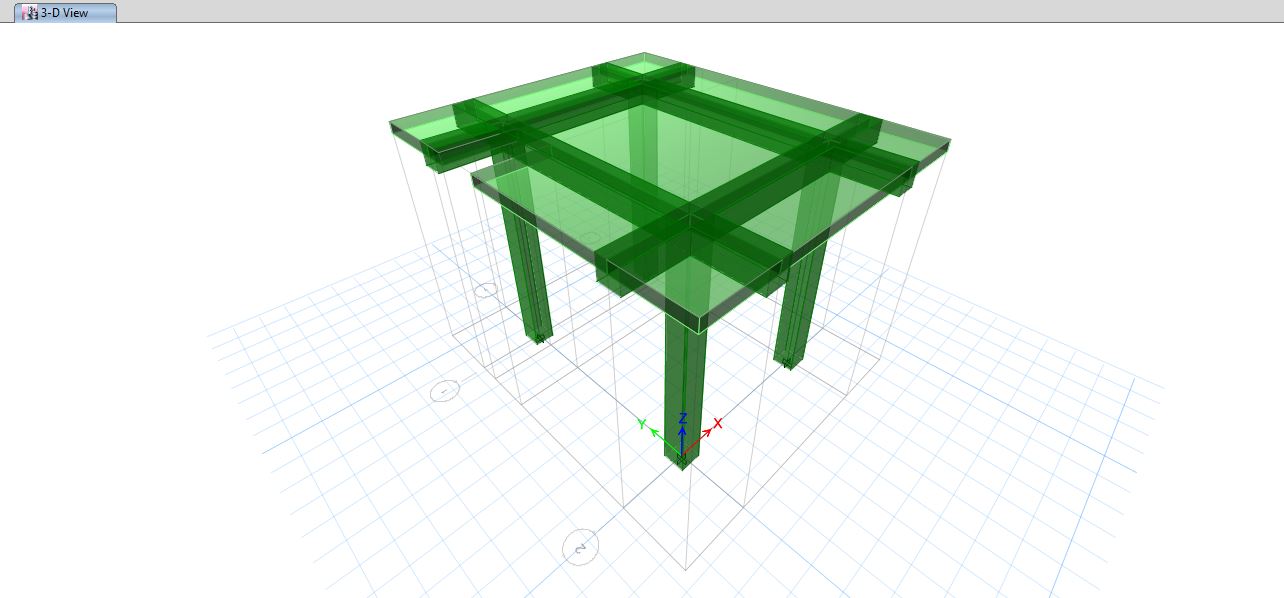
| **Category** | | **Load Combination** |
| --- | --- | --- |
| Category A | Operation Without Wind | 1.0(DL+ DLempty + LLop) |
| 1.0(DL+ DLempty + LLop + LL + TL ± TLst ± FR) |
| 1.0(DL+ DLempty + LLop + TL ± TLst ± FR) + 0.75LL + 0.75S |
| Operation With Wind | 1.0(DL+ DLempty + LLop + TL ± FR) ± WL |
| 1.0(DL+ DLempty + LLop + TL ± FR) + 0.75LL ± 0.75WL |
| 1.0(DL+ DLempty + LLop + TL ± FR) + 0.75LL ± 0.75WL + 0.75S |
| 0.6(DL+ DLempty + LLop+TL + FR) ± WL |
| Category B | Test | 1.0(DL+ DLempty + Test) ± 0.25WL |
| 1.0(DL+ DLempty + Test) + 0.75LL ± 0.25WL + 0.75S |
| 0.6(DL+ DLempty + Test) ± 0.25WL |
| Category C | Erection | 1.0(DL+ DLempty + ER ± WL) |
| 1.0(DL+ DLempty + ER) + 0.75LL ± 0.75WL |
| 0.6(DL+ DLempty + ER) ± WL |
| Category D | Earthquake | 1.0(DL+ DLempty + LLop + TL) ± 0.7EQ |
| 1.0(DL+ DLempty + LLop + TL) ± 0.525EQ + 0.75LL + 0.75S |
| 0.6(DL+ DLempty + LLop+ TL) ± 0.7EQ |
| Category E | Maintenance | 1.0(DL+ DLempty + ML) |
| 1.0(DL+ DLempty+ ML) + 0.75LL ± 0.25WL |
| 0.6(DL+ DLempty+ ML) ± 0.25WL |

**Strength Design:**

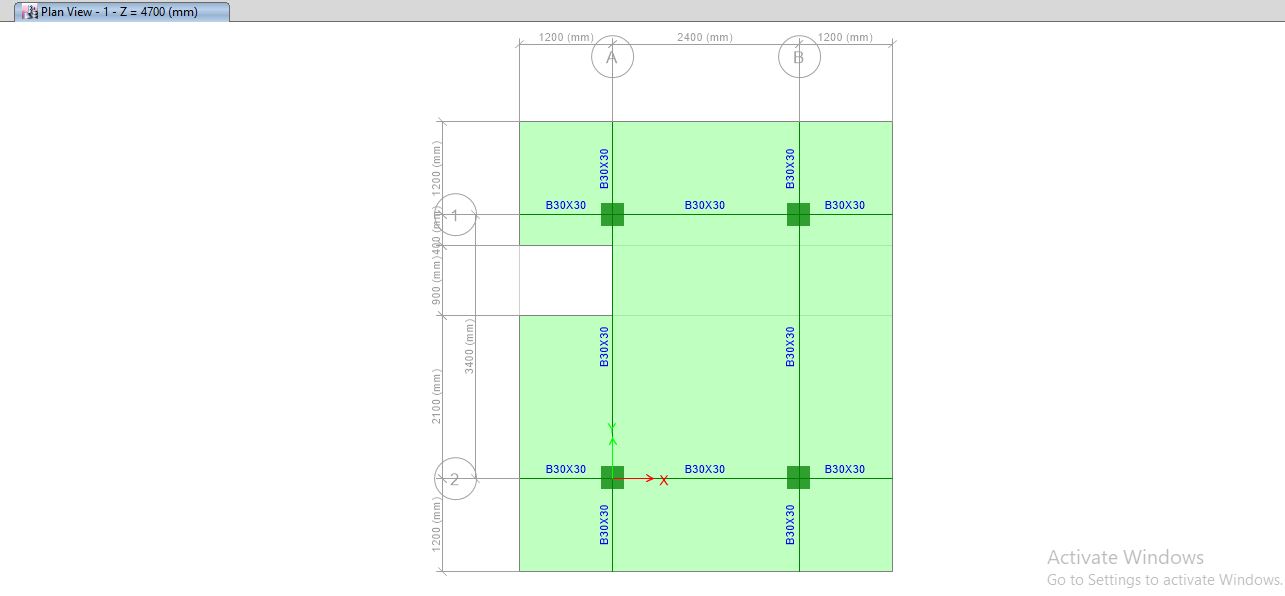
| Category | | Load Combination |
| --- | --- | --- |
| Category A | Operation Without Wind | 1.4(DL+ DLempty + LLop) |
| 1.2(DL+ DLempty + LLop ± FR + TL ± TLst) +1.6LL |
| 1.2(DL+ DLempty + LLop ± FR + TL ± TLst) +1.6LL + 0.5S |
| Operation With Wind | 1.2(DL+ DLempty + LLop ± FR + TL) + 1.0LL ± 1.6WL + 0.5S |
| 1.2(DL+ DLempty + LLop ± FR + TL) ± 0.8WL + 1.6S |
| 0.9(DL+ DLempty + LLop ± FR + TL) ± 1.6WL |
| Category B | Test | 1.2(DL+ DLempty + Test ) + 1.0LL ± 1.6(0.25WL) + 0.5S |
| 1.2(DL+ DLempty + Test ) + 1.6LL + 0.5S |
| 0.9(DL+ DLempty + Test ) ± 1.6(0.25WL) |
| Category C | Erection | 1.2(DL+ DLempty + ER) + 1.6LL |
| 1.2(DL+ DLempty + ER) + 1.0LL ± 0.8WL |
| 0.9(DL+ DLempty + ER) ± 1.6WL |
| Category D | Earthquake | 1.2( DL+ DLempty + LLop + TL) + 1.0LL ± 1.0EQ + 0.2S |
| 0.9( DL+ DLempty + LLop+ TL) ± 1.0EQ |
| Category E | Maintenance | 1.2(DL+ DLempty + ML ) + 1.0LL ± 1.6(0.25WL) |
| 1.2(DL+ DLempty + ML ) + 1.6(LL) |
| 0.9(DL+ DLempty+ ML) ± 1.6(0.25WL) |

1. **STRUCTURE ANALYSIS AND DESIGN**

The steel structure is checked in accordance with LRFD method. Frame analysis and structural checks are based on the 3D model that covers all the Load Combinations.



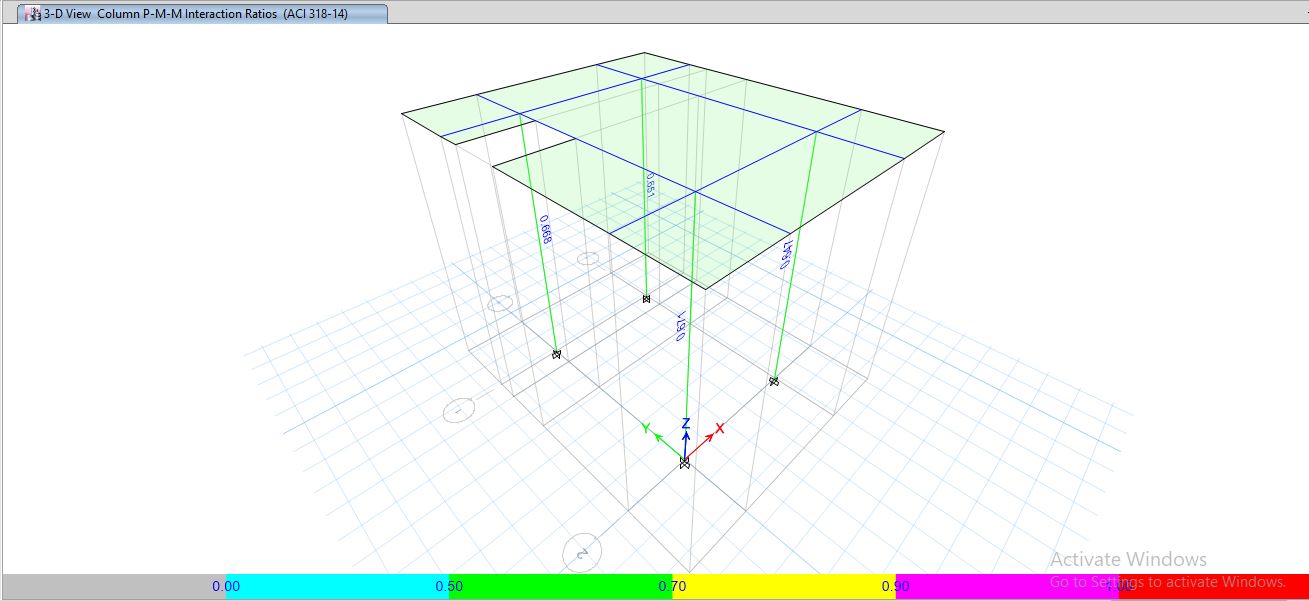
**Figure 9: 3D model of ETABS**



**Figure 10 : Plan View**

1. **Structural Design Results**

The design of these elements is done by software facilities according to Code ACI-318-14. Summary of the results for columns and beams design is shown in the following figures.

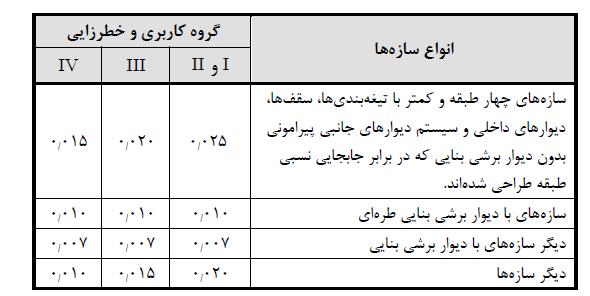


**Figure 11: Ratio Check**

For all elements D/C ratio shall be ≤ 1, according to above output all elements are ok.

1. **DRIFT CONTROL**

According to “Iranian Seismic Design Code for Petroleum Facilities (Pub.038-3rd edition)” Table 4-8, drift shall not exceed 0.02.



The deflection at level X () (in. or mm) used to compute the design story drift, Δ, shall be determined in accordance with the following equation:

Equation 4-22 (Pub.038-3rd edition, part 4-14-1):

Maximum displacement in x direction due to earthquake: 6.298 mm

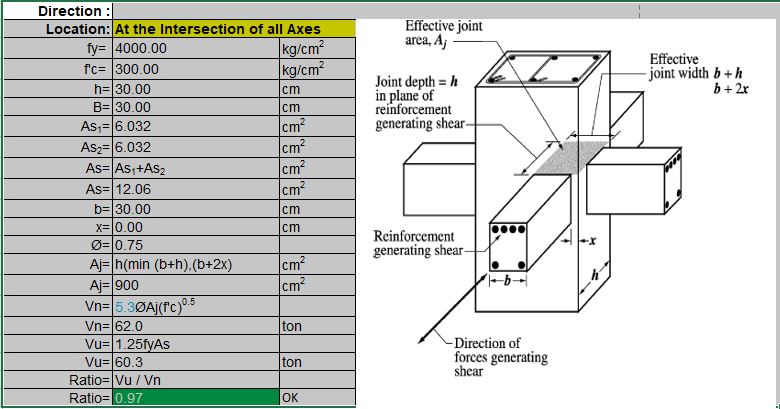
Also

Maximum displacement in y direction due to earthquake: 6.682 mm

,

1. **Joist shear capacity ratio CONTROL**

According to ACI 318-14 part 18-8-4, shear strength of connection has been controlled and for all columns have been shown below.



1. **Strong Column-Weak Beam Requirements in SPECIAL CONCRETE Moment Frame**

According to INBC Part 9 (section: 9-20-60-4), the flexural strength of columns shall satisfy:

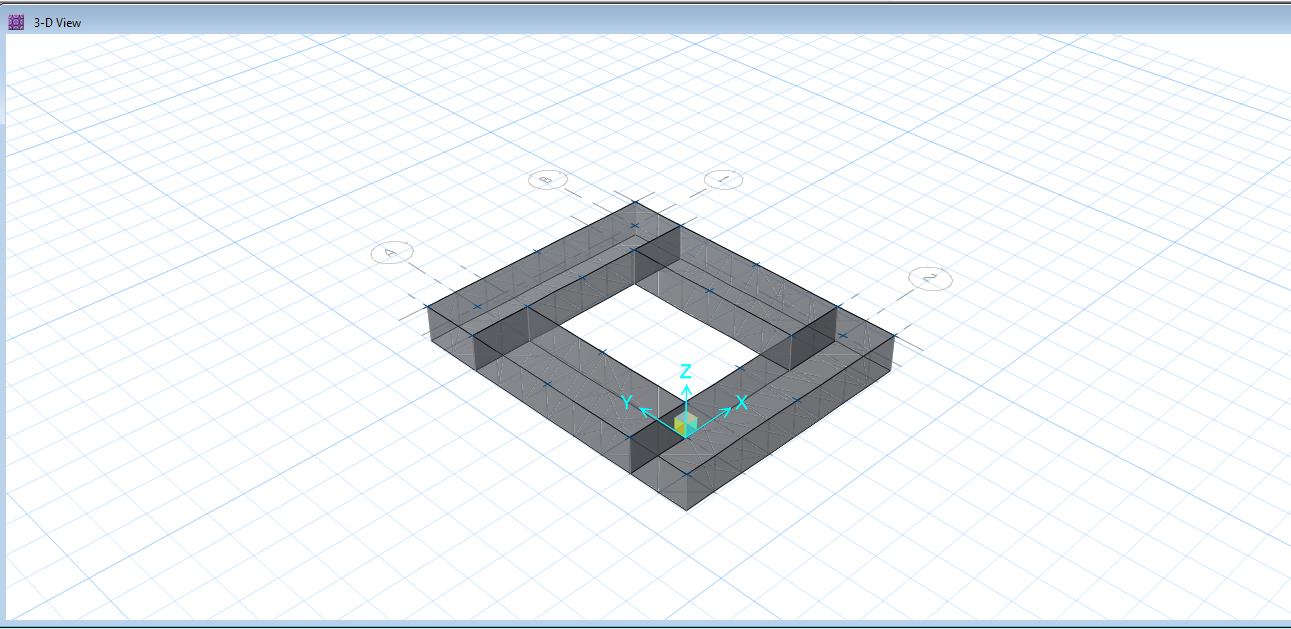
ΣMnc ≥ 1.2 ΣMnb

Based on Etabs report, maximum force due to seismic load combination is equal to 11.0 ton which is smaller than 0.1Ag f’c , so according to section 9-20-6-4-5 could be ignored above equation for one story building.

1. **FOUNDATION DESIGN AND RESULTS**

## Foundation Model

Foundation model, analyse and design has been done by SAFE2016 software.



**Figure 12: Foundation 3D plan in SAFE**

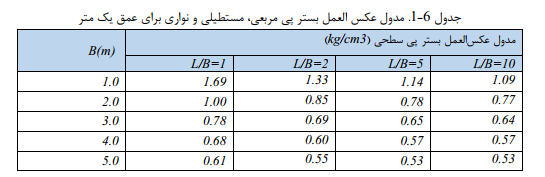
## Soil cHARACTERISTIC

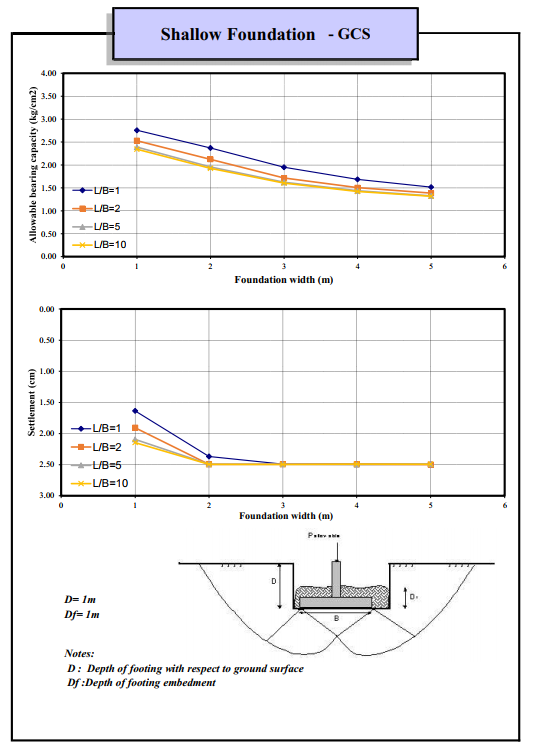
Based on Geotechnical Report (Attachment 4, 5):

q allowable = 1.75 kg/cm2 (Allowable Soil Bearing Capacity)

δ allowable = 1.6 cm (Allowable Settlement)

Ks = 1.6 kg/cm3 (Subgrade Modulus)





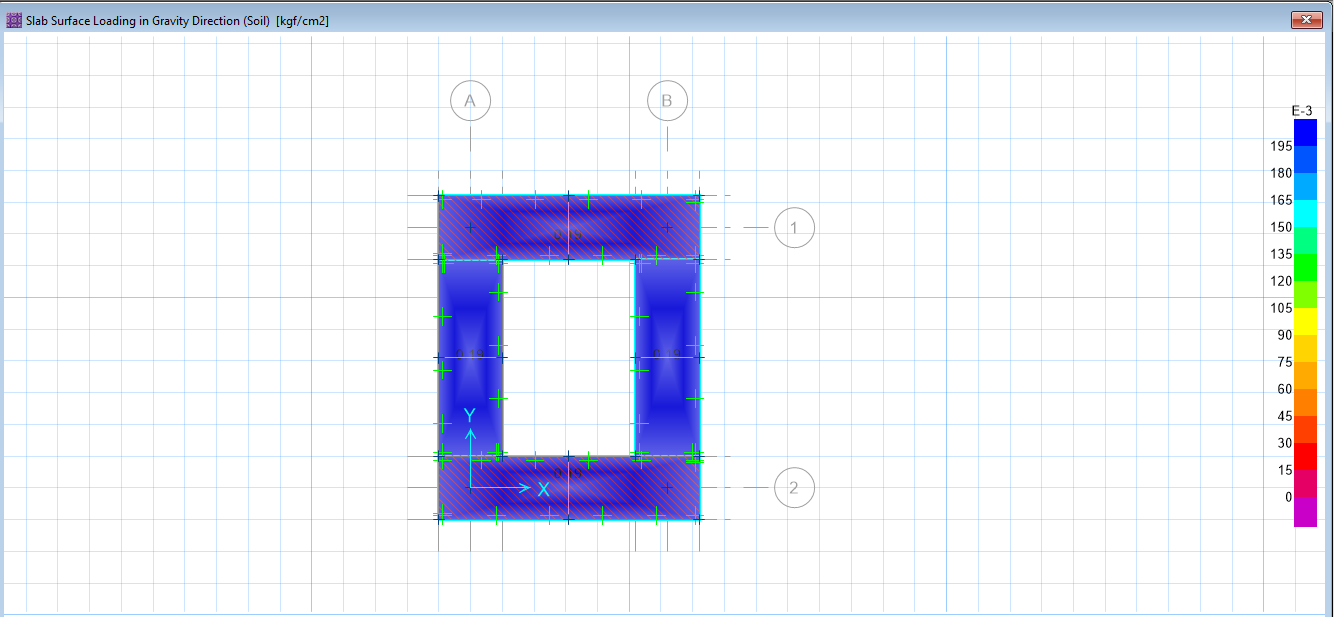
## Loads

The loads have been imported from ETABS analysis.

Reinforced concrete unit weight equals 2500 kg/m3 and defined for SAFE, so the program calculated the foundation weight automatically.

Soil unit weight equals to 1900 kg/m3. The soil height above foundation is 1.0 m, so distributed soil weight:

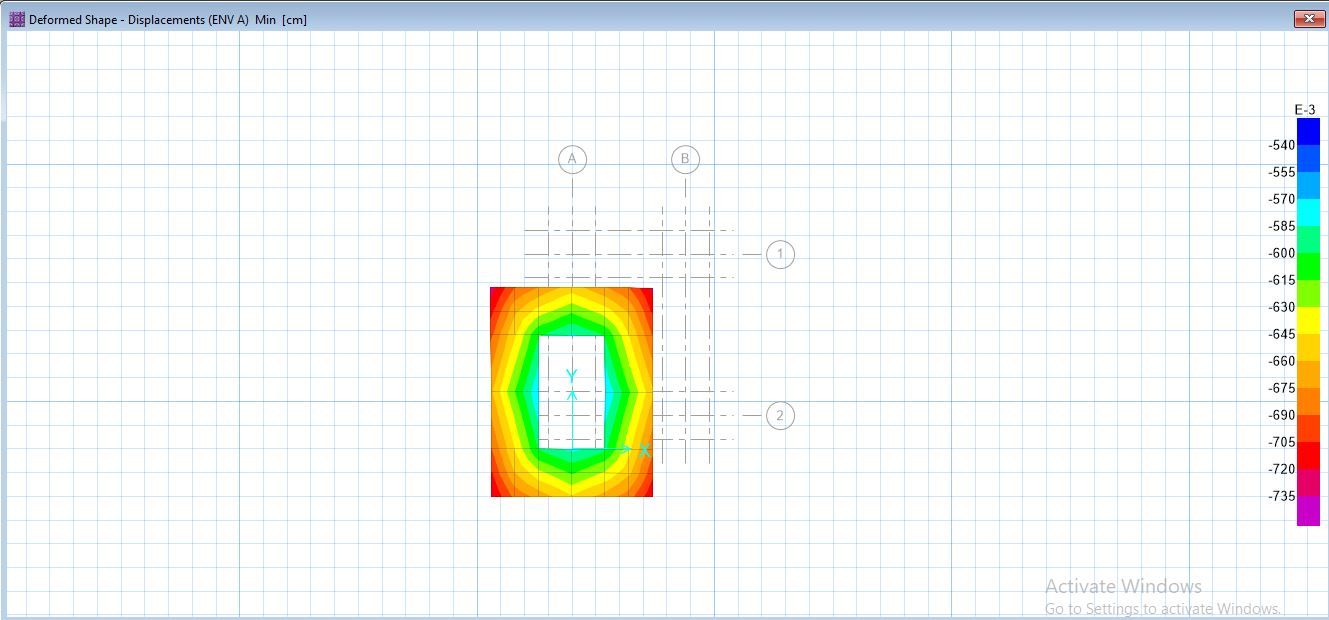
Ws = 1.0×1900 = 1900 kg/m2



**Figure 13 : soil weight on foundation**

## Settlement Control

Settlement in different service load combinations should be checked by allowable value.

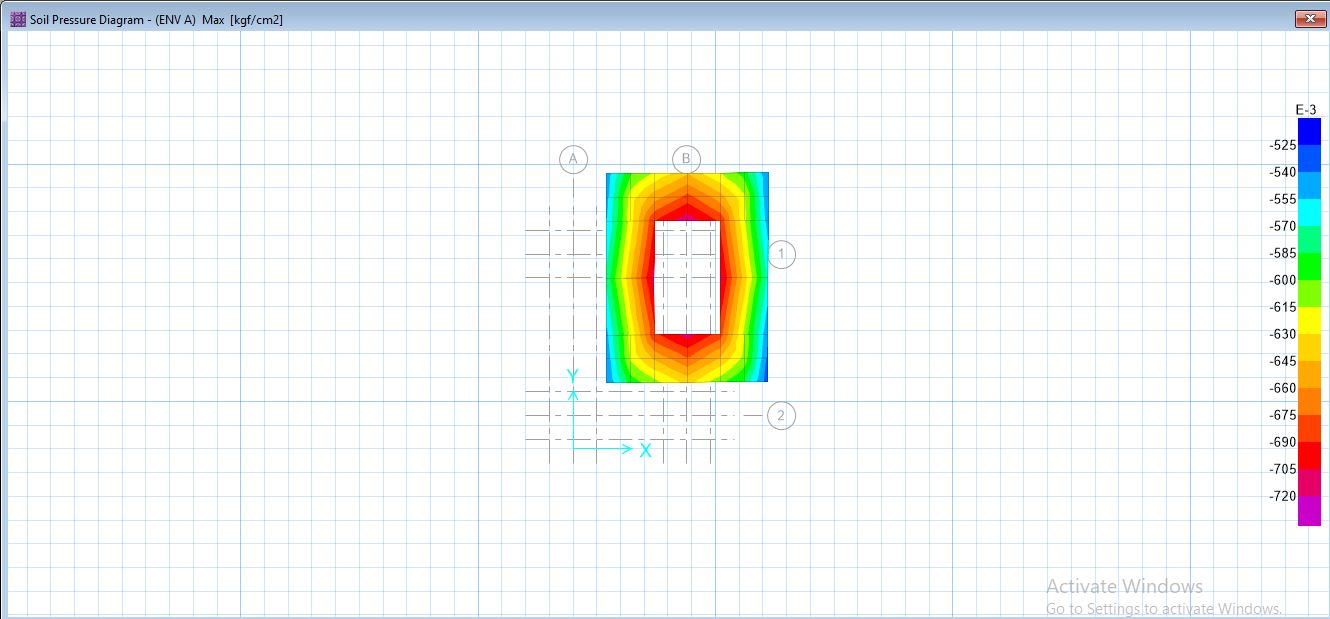
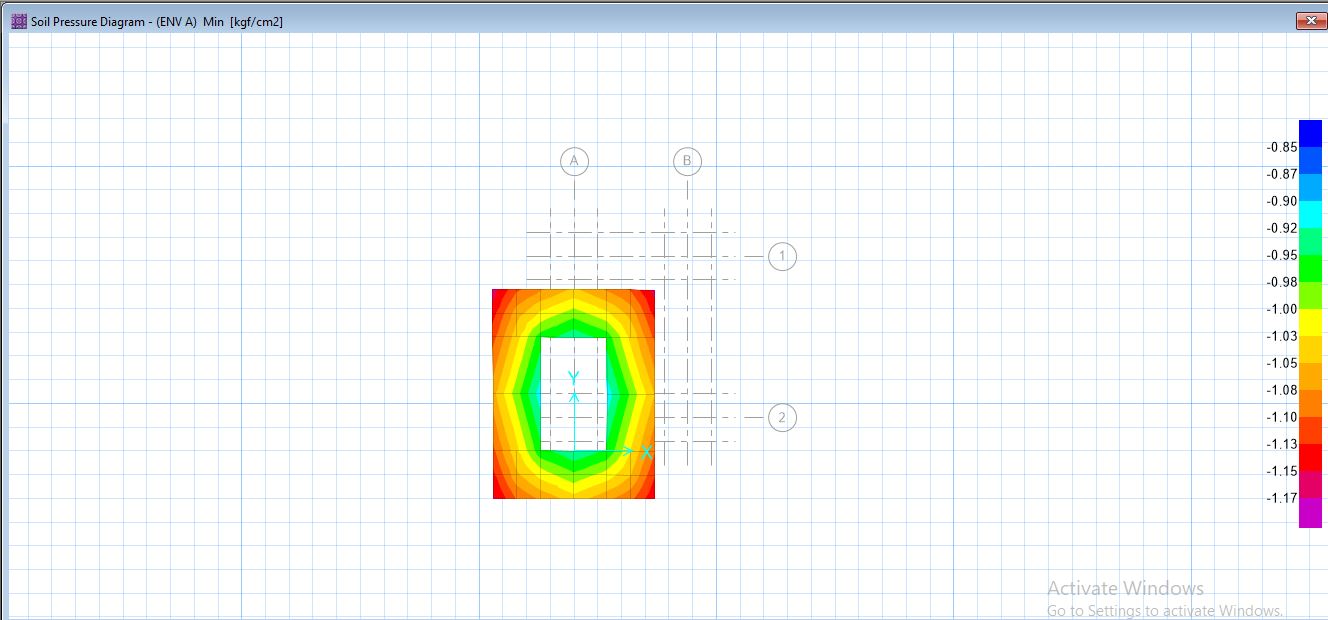


**Figure 14 : Foundation Settlement**

Maximum settlement of foundation equals to 0.72 cm, which is less than allowable 1.6 cm.

## Soil pressure control

Soil pressures in different service load combinations should be checked by allowable value.

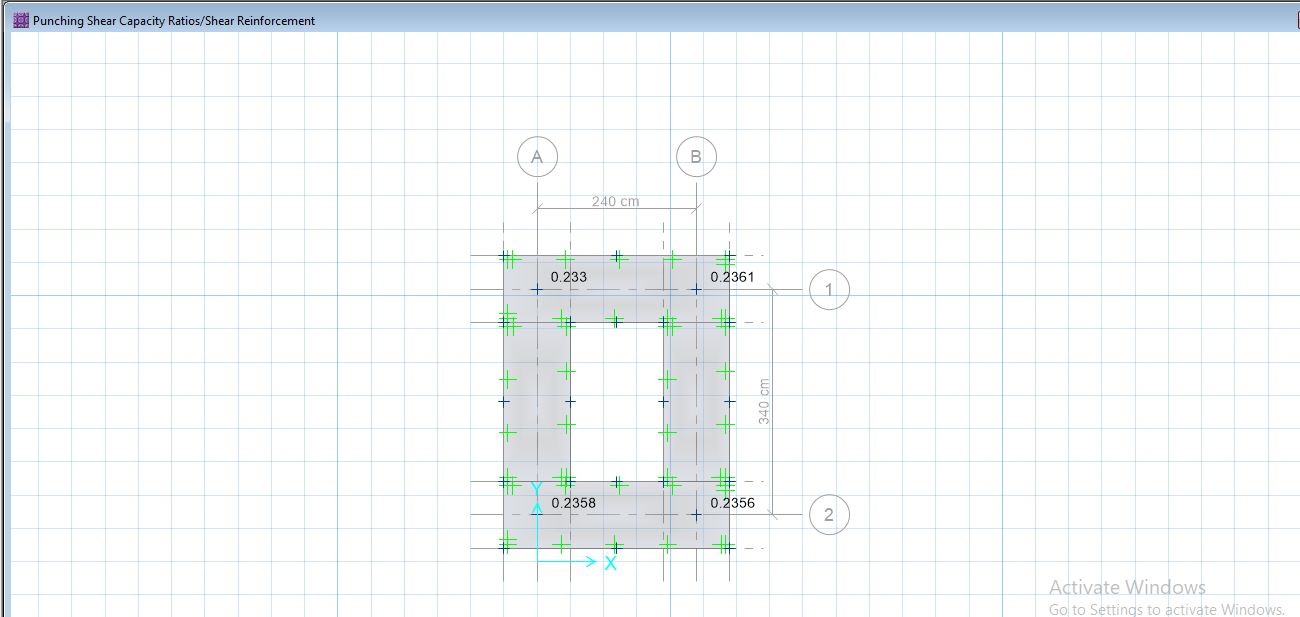


**Figure 15 : Soil Pressure under Foundation**

Maximum soil pressure under foundation equals to 1.165 kg/cm2, which is less than1.75 kg/cm2.

## Punching Shear Control

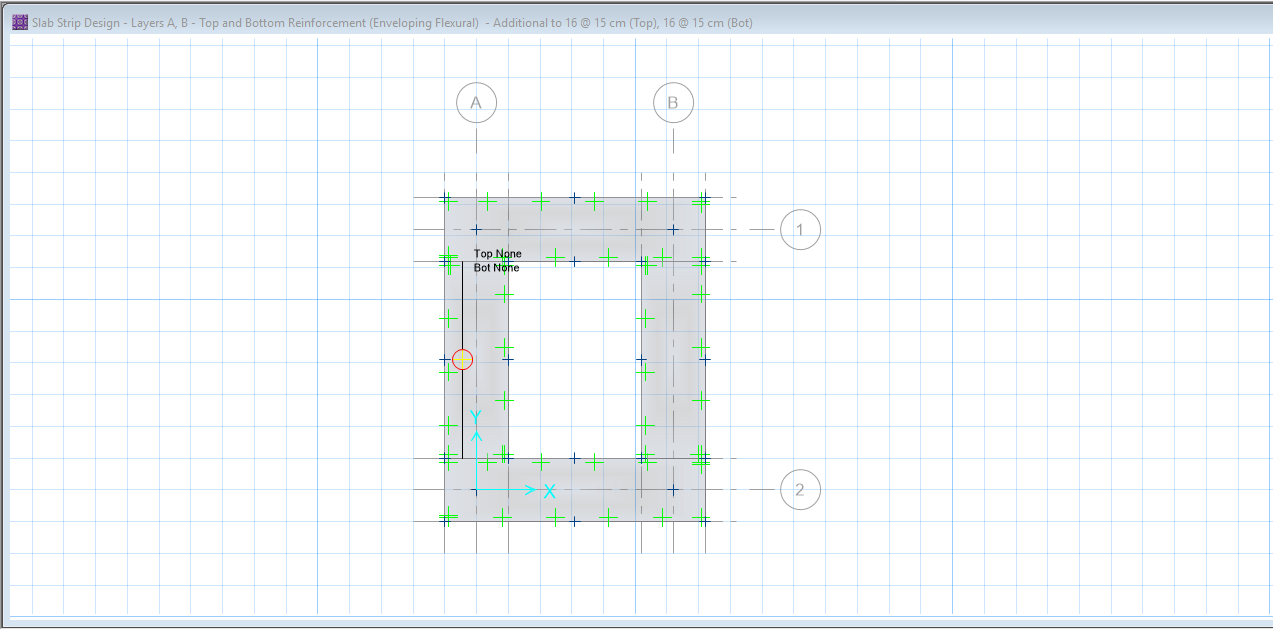
The punching shear control ratio of foundation is shown below. As seen the punching shear ratio in all columns base which is calculated by software is less than allowable range (1.0), so the footing thickness is acceptable.



**Figure 16 : Punching Shear Capacity Ratios**

## Foundation Design

Foundation reinforcement is calculated by software and add bars in X, Y direction are shown at below figure. Uniform Ф16@150 pattern is assigned for top and bottom of foundation in both directions and needed additional bars at some part that is presented in below pictures.



**Figure 17: Reinforcement in X, Y Direction**

In Both Directions:

Top Bar USE Φ16@150 mm

Bottom Bar USE Φ16@150 mm

Minimum rebar for strip foundation: