





نگهداشت و افزایش تولید میدان نفتی بینک  
سطح الارض و ابنیه تحت الارض

احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک



شماره پیمان:

053-073-9184

CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION

| نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |
|------|-------|----------|------|---------|-----------|-----------|-------|
| D01  | 0006  | CN       | ST   | 120     | PEDCO     | GCS       | BK    |

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| پروژه                                                                                          | بسته کاری                                                                                                                                                                                                                                                                                                                                 | صادرکننده                                                                           | تسهیلات | رشته | نوع مدرک | سریال | نسخه |  |  |       |           |           |         |      |          |       |      |    |     |       |     |    |    |      |     |                      |
| BK                                                                                             | GCS                                                                                                                                                                                                                                                                                                                                       | PEDCO                                                                               | 120     | ST   | CN       | 0006  | D01  |  |  |       |           |           |         |      |          |       |      |    |     |       |     |    |    |      |     |                      |

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| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |         |      |          |       |      |  |  |       |           |           |         |      |          |       |      |    |     |       |     |    |    |      |     |                      |
| پروژه                                                                                      | بسته کاری                                                                                                                                                                                                                                                                                                                                 | صادرکننده                                                                           | تسهیلات | رشته | نوع مدرک | سریال | نسخه |  |  |       |           |           |         |      |          |       |      |    |     |       |     |    |    |      |     |                      |
| BK                                                                                         | GCS                                                                                                                                                                                                                                                                                                                                       | PEDCO                                                                               | 120     | ST   | CN       | 0006  | D01  |  |  |       |           |           |         |      |          |       |      |    |     |       |     |    |    |      |     |                      |

## 1.0 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.

## 2.0 SCOPE

This report covers the foundation calculation report of the "Gas Compressors Foundation". The foundation modelled by "SAP2000" software.

## NORMATIVE REFERENCE

### 2.1 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
- Iranian Seismic Design Code for Petroleum Facilities(3rd edition)

### 2.2 International Codes and Standards

- C.Arya, W.O'Neil, "Design of Structures and Foundations for Vibrating Machines
- ACI 318. "Building Code Requirements for Reinforced Concrete", American Concrete Institute.
- ACI 351.3R American Concrete Institute– Foundation Dynamic Equipment
- Structural Design Criteria

### 2.3 The Project Documents



- BK-GNRAL-PEDCO-000-ST-SP-0001 Specification for Concrete Work
- BK-GNRAL-PEDCO-000-ST-SP-0004 Specification for Grouting
- BK-GNRAL-PEDCO-000-ST-DC-0001 Structural Design Criteria
- BK-GCS-PEDCO-120-ST-DW-0059 Foundation Drawing For Gas Compressor Shelter
- BK-GCS-PEDCO-120-ST-DW-0060 Structural Drawing For Gas Compressor

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| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک                                                                            | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                      | CN                                                                                  | ST   | 120     | PEDCO     | GCS       | BK    |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |

Shelter

- BK-GCS-PEDCO-120-GT-RT-0001 Geotechnical Investigation Report for Compressor Station
- BK-GCS-HY-120-ME-DW-0001 Compressor Package General Arrangement

### 3.0 MATERIAL PROPERTIES

Material properties are delivered in the following table.

TABLE 1 -MATERIAL PROPERTIES

| Foundation Concrete      | F'c = 30 Mpa(28- day cylindrical sample)                        |
|--------------------------|-----------------------------------------------------------------|
| Long. reinforcement bar  | Fy = 400 Mpa(AIII)                                              |
| Trans. reinforcement bar | Fy = 400 Mpa(AIII)                                              |
| Soil Shear modulus       | G=2.9e7 (kg/m^2) According to geotechnical investigation report |

General Data

Material Name and Display Color: AIII

Material Type: Rebar

Material Grade: Grade 60

Material Notes: Modify/Show Notes...

Weight and Mass

Weight per Unit Volume: 7.850E-03

Mass per Unit Volume: 8.005E-06

Units: Kgf, cm, C

Uniaxial Property Data

Modulus Of Elasticity, E: 2038901.9

Poisson, U: 0.3

Coefficient Of Thermal Expansion, A: 1.170E-05

Shear Modulus, G:

Other Properties For Rebar Materials

Minimum Yield Stress, Fy: 4000.

Minimum Tensile Stress, Fu: 6000.

Expected Yield Stress, Fye: 4000.

Expected Tensile Stress, Fue: 6000.

☐ Switch To Advanced Property Display

OK Cancel

General Data

Material Name and Display Color: CONC

Material Type: Concrete

Material Grade:

Material Notes: Modify/Show Notes...

Weight and Mass

Weight per Unit Volume: 2.500E-03

Mass per Unit Volume: 2.549E-06

Units: Kgf, cm, C

Isotropic Property Data

Modulus Of Elasticity, E: 239000.

Poisson, U: 0.35

Coefficient Of Thermal Expansion, A: 1.170E-05

Shear Modulus, G: 88518.52

Other Properties For Concrete Materials

Specified Concrete Compressive Strength, fc: 300.

Expected Concrete Compressive Strength: 300.

☐ Lightweight Concrete

Shear Strength Reduction Factor:

☐ Switch To Advanced Property Display

OK Cancel



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شماره صفحه : 6 از 30

جدول مقادیر پارامترهای دینامیک در موقعیت گمانه ماشین BH-2

| Depth(m) | Vp (m/s) | Vs (m/s) | $\gamma$ (KN/m <sup>3</sup> ) | $\rho$ KN.s <sup>2</sup> /m <sup>4</sup> | E=2G(1+ $\mu$ ) (Gpa) | G= $\rho$ .Vs <sup>2</sup> (Gpa) | $\mu$ |
|----------|----------|----------|-------------------------------|------------------------------------------|-----------------------|----------------------------------|-------|
| 0        | 825.3    | 184.9    | 19.13                         | 1.95                                     | 0.20                  | 0.07                             | 0.474 |
| 1        | 825.3    | 184.9    | 19.13                         | 1.95                                     | 0.20                  | 0.07                             | 0.474 |
| 2        | 1349.0   | 329.2    | 19.13                         | 1.95                                     | 0.62                  | 0.21                             | 0.468 |
| 3        | 1349.0   | 427.2    | 19.13                         | 1.95                                     | 1.03                  | 0.36                             | 0.444 |
| 4        | 1403.6   | 427.2    | 20.11                         | 2.05                                     | 1.08                  | 0.37                             | 0.449 |
| 5        | 1466.2   | 479.4    | 20.11                         | 2.05                                     | 1.36                  | 0.47                             | 0.440 |
| 6        | 1466.2   | 479.4    | 20.11                         | 2.05                                     | 1.36                  | 0.47                             | 0.440 |
| 7        | 1507.0   | 492.8    | 20.11                         | 2.05                                     | 1.43                  | 0.50                             | 0.440 |
| 8        | 1527.8   | 526.0    | 20.60                         | 2.1                                      | 1.66                  | 0.58                             | 0.433 |
| 9        | 1551.2   | 526.0    | 20.60                         | 2.1                                      | 1.67                  | 0.58                             | 0.435 |
| 10       | 1551.2   | 529.8    | 20.60                         | 2.1                                      | 1.69                  | 0.59                             | 0.434 |
| 11       | 1499.6   | 504.4    | 20.60                         | 2.1                                      | 1.53                  | 0.53                             | 0.436 |
| 12       | 1499.6   | 504.4    | 20.60                         | 2.1                                      | 1.53                  | 0.53                             | 0.436 |
| 13       | 1550.2   | 533.4    | 20.60                         | 2.1                                      | 1.71                  | 0.60                             | 0.433 |
| 14       | 1586.0   | 559.0    | 20.60                         | 2.1                                      | 1.88                  | 0.66                             | 0.429 |
| 15       | 1586.0   | 559.0    | 20.60                         | 2.1                                      | 1.88                  | 0.66                             | 0.429 |
| 16       | 1650.5   | 573.0    | 20.60                         | 2.1                                      | 1.97                  | 0.69                             | 0.431 |
| 17       | 1700.1   | 583.9    | 20.60                         | 2.1                                      | 2.05                  | 0.72                             | 0.433 |
| 18       | 1700.1   | 584.3    | 20.60                         | 2.1                                      | 2.05                  | 0.72                             | 0.433 |
| 19       | 1730.5   | 584.3    | 20.60                         | 2.1                                      | 2.06                  | 0.72                             | 0.436 |
| 20       | 1722.0   | 602.9    | 20.60                         | 2.1                                      | 2.18                  | 0.76                             | 0.430 |
| 21       | 1722.0   | 602.9    | 20.60                         | 2.1                                      | 2.18                  | 0.76                             | 0.430 |
| 22       | 1786.2   | 610.8    | 20.60                         | 2.1                                      | 2.25                  | 0.78                             | 0.434 |
| 23       | 1743.8   | 596.0    | 20.60                         | 2.1                                      | 2.14                  | 0.75                             | 0.434 |
| 24       | 1787.2   | 596.0    | 20.60                         | 2.1                                      | 2.14                  | 0.75                             | 0.437 |
| 25       | 1787.2   | 603.6    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.436 |
| 26       | 1809.9   | 603.7    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.437 |
| 27       | 1808.9   | 603.7    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.437 |
| 28       | 1810.2   | 603.8    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.437 |
| 29       | 1810.4   | 603.9    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.437 |
| 30       | 1810.4   | 603.9    | 20.60                         | 2.1                                      | 2.20                  | 0.77                             | 0.437 |

مقادیر پیشنهادی پارامترهای فیزیکی و مکانیکی لایه‌های طبیعی

| Layer type according to Unified method | CL        | Marl (CL) | Marl (CL) | Unit   |
|----------------------------------------|-----------|-----------|-----------|--------|
| Depth                                  | 0.5-3.5   | 3.5-7.5   | 7.5-30    | m      |
| Soil cohesion (Cu)                     | 1.0-2.0   | 2.5-5.0   | 4.0-8.0   | kg/cm2 |
| Soil wet density ( $\rho_w$ )          | 1.9-2.0   | 1.95-2.15 | 2.0-2.2   | g/cm3  |
| Soil module of elasticity (Es)         | 200-400   | 500-1000  | 800-1600  | kg/cm2 |
| Soil Poisson ratio ( $\nu$ )           | 0.35-0.40 | 0.30-0.35 | 0.30-0.35 | -      |

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|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|------------|-----------|-------|--|--|------|-------|----------|------|---------|------------|-----------|-------|-----|------|----|----|-----|-------|-----|----|----------------------|
| شماره پیمان:<br>053-073-9184                                                               | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |            |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادر کننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 7 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                            |                                                                                     |      |         |            |           |       |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                      |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                      | نوع مدرک                                                                            | رشته | تسهیلات | صادر کننده | بسته کاری | پروژه |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                      |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                       | CN                                                                                  | ST   | 120     | PEDCO      | GCS       | BK    |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                      |

## 4.0 LOADS

| TABLE: Load Pattern Definitions |            |            |                                                                   |
|---------------------------------|------------|------------|-------------------------------------------------------------------|
| LoadPat                         | DesignType | SelfWtMult | Description                                                       |
| Text                            | Text       | Unitless   |                                                                   |
| DEAD                            | Dead       | 1          | Foundation + Pedestal + Compressor + Its Attachment + Soil        |
| LIVE                            | Live       | 0          |                                                                   |
| OPER                            | Other      | 0          |                                                                   |
| CP-FY                           | Other      | 0          |                                                                   |
| CP-MZ                           | Other      | 0          |                                                                   |
| M-FY                            | Other      | 0          |                                                                   |
| M-FZ                            | Other      | 0          |                                                                   |
| CS-FY                           | Other      | 0          |                                                                   |
| CS-MZ                           | Other      | 0          |                                                                   |
| EQX                             | Other      | 0          |                                                                   |
| EQY                             | Other      | 0          |                                                                   |
| X25%                            | Other      | 0          | Transversal forces representing 25% of the weight of each machine |
| Y25%                            | Other      | 0          | Transversal forces representing 25% of the weight of each machine |
| Z50%                            | Other      | 0          | Transversal forces representing 50% of the weight of each machine |
| ABNORM                          | Other      | 0          |                                                                   |

### 4.1 Deal Load

Dead loads are included the following loads:

Foundation weight + pedestals weight + soil weight and finally compressors and their attachments.

### 4.2 Operation Load

According to vendor data sheet the following loads are applied to the models

| Equipment List |                                |             |
|----------------|--------------------------------|-------------|
| No             | DESCRIPTION                    | Weight (Kg) |
| 1              | Skid & GB                      | 25000       |
| 2              | Bare Block and Flywheel        | 33000       |
| 3              | Distance Piece Collection Pot  | 70          |
| 4              | Packing Leakage Collection Pot | 62          |
| 5              | Suction Snubber St.1           | 1448.7      |
| 6              | Discharge Snubber St.1         | 1375.2      |
| 7              | Suction Snubber St.2           | 1441.7      |
| 8              | Discharge Snubber St.2         | 1495.7      |
| 9              | Electrical Motor 1070 kW       | 17850       |
| Total Weight   |                                | 81743       |

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|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|-----------|-----------|-------|--|--|------|-------|----------|------|---------|-----------|-----------|-------|-----|------|----|----|-----|-------|-----|----|----------------------|
| شماره پیمان:<br>053 - 073 - 9184                                                           | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |           |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 8 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک                                                                            | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                      | CN                                                                                  | ST   | 120     | PEDCO     | GCS       | BK    |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                      |

### 4.3 Dynamic Load

| Compressor |               |           |           |            |           |
|------------|---------------|-----------|-----------|------------|-----------|
| FORCE      |               |           | Moment    |            |           |
| Direction  | Force (N,P.P) | Frequency | Direction | (N.m)      | Frequency |
| X          | 7438          | Primary   | X         | 391        | Primary   |
| X          | 1234          | Secondary | X         | 0 (note 2) | Secondary |
| Y          | 0 (note 2)    | Primary   | Y         | 0 (note 2) | Primary   |
| Y          | 0 (note 2)    | Secondary | Y         | 0 (note 2) | Secondary |
| Z          | 3125          | Primary   | Z         | 18314.6    | Primary   |
| Z          | 0 (note 2)    | Secondary | Z         | 20060      | Secondary |

| Electric Motor                       |         |
|--------------------------------------|---------|
| Rated dynamic load                   | 8.6kN   |
| Two-phase short-circuit dynamic load | 53.4kN  |
| Live Load                            | 12 kPa  |
| Motor Speed                          | 424 rpm |

### 4.4 Earthquake Load

Seismic loads applied to the model manually and its calculations are mentioned below:

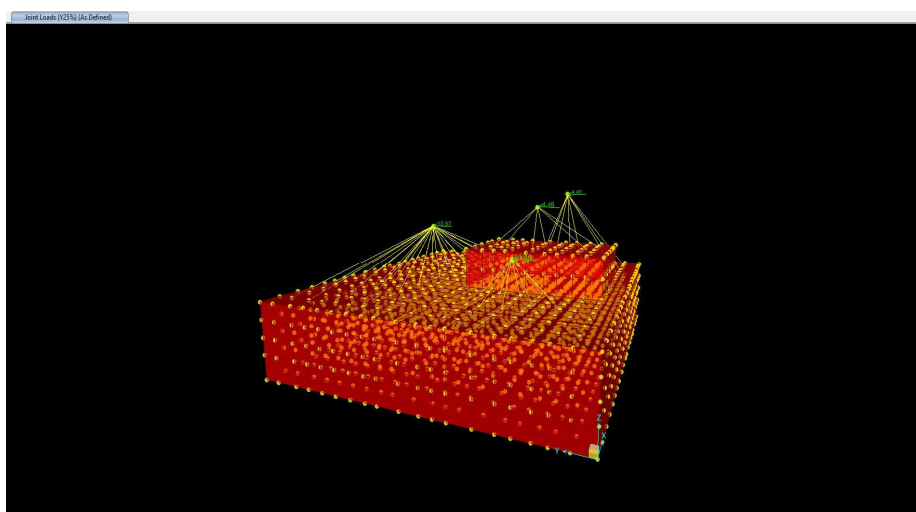
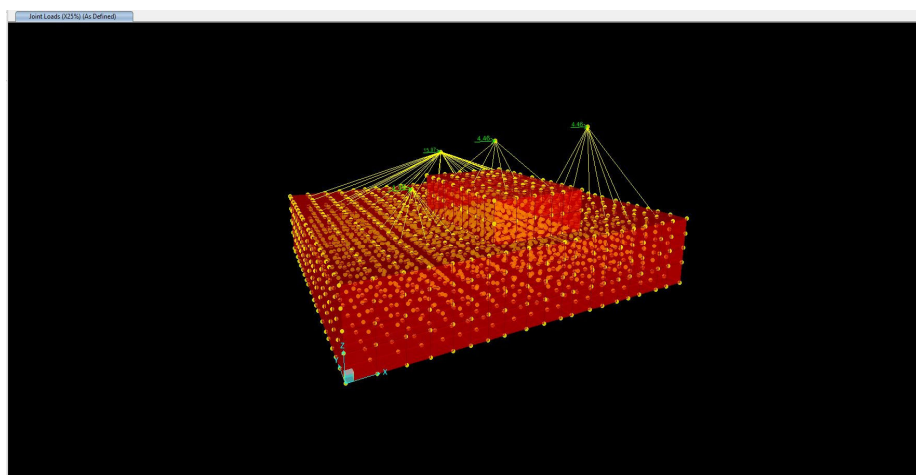
$$V=0.7 \cdot C_a \cdot I \cdot W$$

$$V=0.7 \cdot 0.3 \cdot 1.25 \cdot W=0.263W$$

### 4.5 25% Operating Load

According to regulations, 25% of the compressor's operating loads must be applied as dynamic loads in both directions.

|                                                                                            |                                                                                                                                    |           |           |         |      |          |       |                                                                                     |
|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|
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| 053 – 073 – 9184                                                                           | پروژه                                                                                                                              | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     |
|                                                                                            | BK                                                                                                                                 | GCS       | PEDCO     | 120     | ST   | CN       | 0006  | D01                                                                                 |

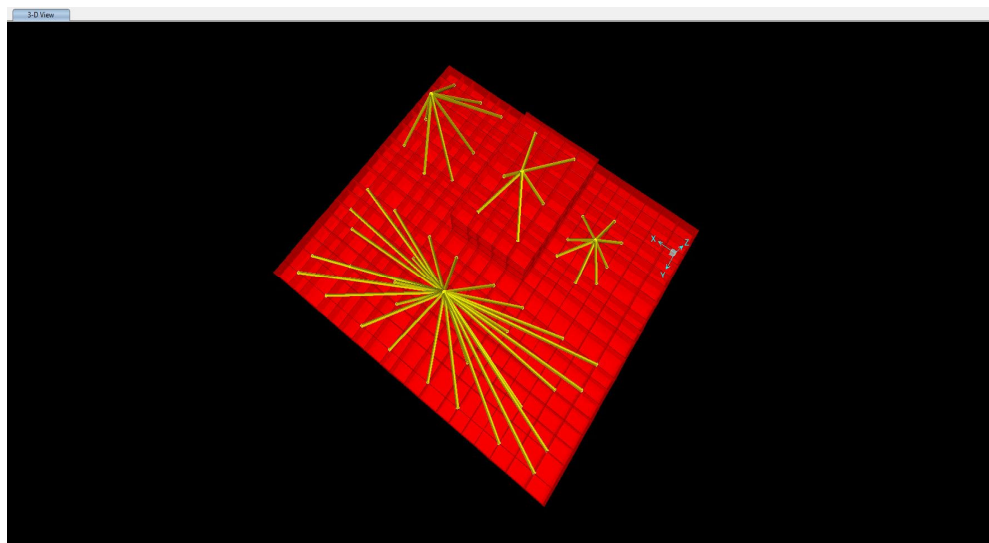


## 5.0 ANALYSIS

### 5.1 3d Model

SAP 2000 was applied for model this foundation and for more accuracy, solids elements have been used for checking of pressure and displacement of foundation.

|                                                                                            |                                                                                                                                       |           |            |         |      |          |       |                                                                                     |                       |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|---------|------|----------|-------|-------------------------------------------------------------------------------------|-----------------------|
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| شماره پیمان:<br>053 – 073 – 9184                                                           | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                       |           |            |         |      |          |       |                                                                                     | شماره صفحه : 10 از 30 |
|                                                                                            | پروژه                                                                                                                                 | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه                                                                                |                       |
|                                                                                            | BK                                                                                                                                    | GCS       | PEDCO      | 120     | ST   | CN       | 0006  | D01                                                                                 |                       |



## 5.2 Analysis Cases

| TABLE: Load Pattern Definitions |            |            |
|---------------------------------|------------|------------|
| LoadPat                         | DesignType | SelfWtMult |
| Text                            | Text       | Unitless   |
| DEAD                            | Dead       | 1          |
| LIVE                            | Live       | 0          |
| OPER                            | Other      | 0          |
| CP-FY                           | Other      | 0          |
| CP-MZ                           | Other      | 0          |
| M-FY                            | Other      | 0          |
| M-FZ                            | Other      | 0          |
| CS-FY                           | Other      | 0          |
| CS-MZ                           | Other      | 0          |
| EQX                             | Other      | 0          |
| EQY                             | Other      | 0          |
| X25%                            | Other      | 0          |
| Y25%                            | Other      | 0          |
| Z50%                            | Other      | 0          |
| ABNORM                          | Other      | 0          |



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شماره پیمان:

053-073-9184

CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION

| نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |
|------|-------|----------|------|---------|-----------|-----------|-------|
| D01  | 0006  | CN       | ST   | 120     | PEDCO     | GCS       | BK    |

شماره صفحه : 11 از 30

Load Case Data - Linear Modal History

Load Case Name: CP-FYhis Set Def Name Notes: Modify/Show...

Load Case Type: Time History Design...

Initial Conditions:  
☒ Zero Initial Conditions - Start from Unstressed State  
☐ Continue from State at End of Modal History  
Important Note: Loads from this previous case are included in the current case

Modal Load Case: Use Modes from Case MODAL

Loads Applied:

| Load Type    | Load Name | Function | Scale Factor |
|--------------|-----------|----------|--------------|
| Load Pattern | CP-FY     | SIN-448  | 1.           |
| Load Pattern | CP-FY     | SIN-448  | 1.           |

Add Modify Delete

☐ Show Advanced Load Parameters

Time Step Data:  
Number of Output Time Steps: 3000  
Output Time Step Size: 1.000E-03

Other Parameters:  
Modal Damping: Constant at 0.1 Modify/Show...

Analysis Type:  
☒ Linear  
☐ Nonlinear

Solution Type:  
☒ Modal  
☐ Direct Integration  
☐ Frequency Domain

History Type:  
☒ Transient  
☐ Periodic

Mass Source:  
Previous (MSSSRC1)

OK Cancel

Load Case Data - Linear Modal History

Load Case Name: CP-MZhis Set Def Name Notes: Modify/Show...

Load Case Type: Time History Design...

Initial Conditions:  
☒ Zero Initial Conditions - Start from Unstressed State  
☐ Continue from State at End of Modal History  
Important Note: Loads from this previous case are included in the current case

Modal Load Case: Use Modes from Case MODAL

Loads Applied:

| Load Type    | Load Name | Function | Scale Factor |
|--------------|-----------|----------|--------------|
| Load Pattern | CP-MZ     | SIN-448  | 1.           |
| Load Pattern | CP-MZ     | SIN-448  | 1.           |

Add Modify Delete

☐ Show Advanced Load Parameters

Time Step Data:  
Number of Output Time Steps: 3000  
Output Time Step Size: 1.000E-03

Other Parameters:  
Modal Damping: Constant at 0.1 Modify/Show...

Analysis Type:  
☒ Linear  
☐ Nonlinear

Solution Type:  
☒ Modal  
☐ Direct Integration  
☐ Frequency Domain

History Type:  
☒ Transient  
☐ Periodic

Mass Source:  
Previous (MSSSRC1)

OK Cancel

|                                                                                                   |                                                                                                                                    |           |           |         |      |          |       |                                                                                     |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|
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|                                                                                                   | BK                                                                                                                                 | GCS       | PEDCO     | 120     | ST   | CN       | 0006  | D01                                                                                 |

**Load Case Data - Linear Modal History**

**Load Case Name**  
 CS-FYhis Set Def Name Modify/Show...

**Initial Conditions**  
☒ Zero Initial Conditions - Start from Unstressed State  
☐ Continue from State at End of Modal History  
 Important Note: Loads from this previous case are included in the current case

**Modal Load Case**  
 Use Modes from Case MODAL

**Loads Applied**

| Load Type    | Load Name | Function | Scale Factor |
|--------------|-----------|----------|--------------|
| Load Pattern | CS-FY     | SIN-848  | 1.           |
| Load Pattern | CS-FY     | SIN-848  | 1.           |

Add Modify Delete

☐ Show Advanced Load Parameters

**Time Step Data**  
 Number of Output Time Steps: 3000  
 Output Time Step Size: 1.000E-03

**Other Parameters**  
 Modal Damping: Constant at 0.1 Modify/Show...

**Load Case Type**  
 Time History Design...

**Analysis Type**  
☒ Linear  
☐ Nonlinear

**History Type**  
☒ Transient  
☐ Periodic

**Solution Type**  
☒ Modal  
☐ Direct Integration  
☐ Frequency Domain

**Mass Source**  
 Previous (MSSSRC1)

OK Cancel

**Load Case Data - Linear Modal History**

**Load Case Name**  
 CS-MZhis Set Def Name Modify/Show...

**Initial Conditions**  
☒ Zero Initial Conditions - Start from Unstressed State  
☐ Continue from State at End of Modal History  
 Important Note: Loads from this previous case are included in the current case

**Modal Load Case**  
 Use Modes from Case MODAL

**Loads Applied**

| Load Type    | Load Name | Function | Scale Factor |
|--------------|-----------|----------|--------------|
| Load Pattern | CS-MZ     | SIN-848  | 1.           |
| Load Pattern | CS-MZ     | SIN-848  | 1.           |

Add Modify Delete

☐ Show Advanced Load Parameters

**Time Step Data**  
 Number of Output Time Steps: 3000  
 Output Time Step Size: 1.000E-03

**Other Parameters**  
 Modal Damping: Constant at 0.1 Modify/Show...

**Load Case Type**  
 Time History Design...

**Analysis Type**  
☒ Linear  
☐ Nonlinear

**History Type**  
☒ Transient  
☐ Periodic

**Solution Type**  
☒ Modal  
☐ Direct Integration  
☐ Frequency Domain

**Mass Source**  
 Previous (MSSSRC1)

OK Cancel



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053-073-9184

CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION

| پروژه | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه |
|-------|-----------|-----------|---------|------|----------|-------|------|
| BK    | GCS       | PEDCO     | 120     | ST   | CN       | 0006  | D01  |

شماره صفحه : 13 از 30

Load Case Data - Linear Modal History

Load Case Name: M-his [Set Def Name] Notes: [Modify/Show...]

Load Case Type: [Time History] [Design...]

Initial Conditions:  
☒ Zero Initial Conditions - Start from Unstressed State  
☐ Continue from State at End of Modal History

Important Note: Loads from this previous case are included in the current case

Modal Load Case:  
Use Modes from Case: MODAL

Loads Applied:

| Load Type    | Load Name | Function | Scale Factor |
|--------------|-----------|----------|--------------|
| Load Pattern | M-FY      | SIN-848  | 1.           |
| Load Pattern | M-FY      | SIN-848  | 1.           |
| Load Pattern | M-FZ      | COS-848  | 1.           |

[Add] [Modify] [Delete]

☐ Show Advanced Load Parameters

Time Step Data:  
Number of Output Time Steps: 3000  
Output Time Step Size: 1.000E-03

Other Parameters:  
Modal Damping: Constant at 0.1 [Modify/Show...]

Analysis Type:  
☒ Linear  
☐ Nonlinear

History Type:  
☒ Transient  
☐ Periodic

Solution Type:  
☒ Modal  
☐ Direct Integration  
☐ Frequency Domain

Mass Source:  
Previous (MSSSRC1)

[OK] [Cancel]

|                                                                                            |                                                                                                                                       |           |           |         |      |          |       |                                                                                     |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|
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| 053 – 073 – 9184                                                                           | پروژه                                                                                                                                 | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     |
|                                                                                            | BK                                                                                                                                    | GCS       | PEDCO     | 120     | ST   | CN       | 0006  | D01                                                                                 |

### 5.3 Load Combinations

|    |                                       |                  |                   |                 |                 |                    |
|----|---------------------------------------|------------------|-------------------|-----------------|-----------------|--------------------|
| 1  | <b>TABLE: Combination Definitions</b> |                  |                   |                 |                 |                    |
| 2  | <b>ComboName</b>                      | <b>ComboType</b> | <b>AutoDesign</b> | <b>CaseType</b> | <b>CaseName</b> | <b>ScaleFactor</b> |
| 3  | <b>Text</b>                           | <b>Text</b>      | <b>Yes/No</b>     | <b>Text</b>     | <b>Text</b>     | <b>Unitless</b>    |
| 4  | ST-GR-01                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 5  | ST-GR-01                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 6  | ST-GR-01                              |                  |                   | Linear Static   | OPER            | 1                  |
| 7  | ST-25-01                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 8  | ST-25-01                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 9  | ST-25-01                              |                  |                   | Linear Static   | OPER            | 1                  |
| 10 | ST-25-01                              |                  |                   | Linear Static   | X25%            | 1                  |
| 11 | ST-25-02                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 12 | ST-25-02                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 13 | ST-25-02                              |                  |                   | Linear Static   | OPER            | 1                  |
| 14 | ST-25-02                              |                  |                   | Linear Static   | X25%            | -1                 |
| 15 | ST-25-03                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 16 | ST-25-03                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 17 | ST-25-03                              |                  |                   | Linear Static   | OPER            | 1                  |
| 18 | ST-25-03                              |                  |                   | Linear Static   | Y25%            | 1                  |
| 19 | ST-25-04                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 20 | ST-25-04                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 21 | ST-25-04                              |                  |                   | Linear Static   | OPER            | 1                  |
| 22 | ST-25-04                              |                  |                   | Linear Static   | Y25%            | -1                 |
| 23 | ST-25-05                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 24 | ST-25-05                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 25 | ST-25-05                              |                  |                   | Linear Static   | OPER            | 1                  |
| 26 | ST-25-05                              |                  |                   | Linear Static   | Z50%            | 1                  |
| 27 | ST-25-06                              | Linear Add       | No                | Linear Static   | DEAD            | 1                  |
| 28 | ST-25-06                              |                  |                   | Linear Static   | LIVE            | 1                  |
| 29 | ST-25-06                              |                  |                   | Linear Static   | OPER            | 1                  |
| 30 | ST-25-06                              |                  |                   | Linear Static   | Z50%            | -1                 |
| 31 | ST-EQ-01                              | Linear Add       | No                | Linear Static   | DEAD            | 0.75               |
| 32 | ST-EQ-01                              |                  |                   | Linear Static   | LIVE            | 0.75               |
| 33 | ST-EQ-01                              |                  |                   | Linear Static   | OPER            | 0.75               |
| 34 | ST-EQ-01                              |                  |                   | Linear Static   | EQX             | 0.75               |
| 35 | ST-EQ-02                              | Linear Add       | No                | Linear Static   | DEAD            | 0.75               |
| 36 | ST-EQ-02                              |                  |                   | Linear Static   | LIVE            | 0.75               |
| 37 | ST-EQ-02                              |                  |                   | Linear Static   | OPER            | 0.75               |



نگهداشت و افزایش تولید میدان نفتی بینک  
سطح الارض و ابنیه تحت الارض

احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک



شماره پیمان:

053 - 073 - 9184

CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION

| نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |
|------|-------|----------|------|---------|-----------|-----------|-------|
| D01  | 0006  | CN       | ST   | 120     | PEDCO     | GCS       | BK    |

شماره صفحه : 15 از 30

|    |                                |            |            |                   |          |             |
|----|--------------------------------|------------|------------|-------------------|----------|-------------|
| 1  | TABLE: Combination Definitions |            |            |                   |          |             |
| 2  | ComboName                      | ComboType  | AutoDesign | CaseType          | CaseName | ScaleFactor |
| 3  | Text                           | Text       | Yes/No     | Text              | Text     | Unitless    |
| 38 | ST-EQ-02                       |            |            | Linear Static     | EQX      | -0.75       |
| 39 | ST-EQ-03                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 40 | ST-EQ-03                       |            |            | Linear Static     | LIVE     | 0.75        |
| 41 | ST-EQ-03                       |            |            | Linear Static     | OPER     | 0.75        |
| 42 | ST-EQ-03                       |            |            | Linear Static     | EQY      | 0.75        |
| 43 | ST-EQ-04                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 44 | ST-EQ-04                       |            |            | Linear Static     | LIVE     | 0.75        |
| 45 | ST-EQ-04                       |            |            | Linear Static     | OPER     | 0.75        |
| 46 | ST-EQ-04                       |            |            | Linear Static     | EQY      | -0.75       |
| 47 | ST-ABNRM1                      | Linear Add | No         | Linear Static     | DEAD     | 1           |
| 48 | ST-ABNRM1                      |            |            | Linear Static     | LIVE     | 1           |
| 49 | ST-ABNRM1                      |            |            | Linear Static     | OPER     | 1           |
| 50 | ST-ABNRM1                      |            |            | Linear Static     | ABNORM   | 1           |
| 51 | ST-ABNRM2                      | Linear Add | No         | Linear Static     | DEAD     | 1           |
| 52 | ST-ABNRM2                      |            |            | Linear Static     | LIVE     | 1           |
| 53 | ST-ABNRM2                      |            |            | Linear Static     | OPER     | 1           |
| 54 | ST-ABNRM2                      |            |            | Linear Static     | ABNORM   | -1          |
| 55 | DN-01                          | Linear Add | No         | Linear Static     | DEAD     | 1           |
| 56 | DN-01                          |            |            | Linear Static     | LIVE     | 1           |
| 57 | DN-01                          |            |            | Linear Static     | OPER     | 1           |
| 58 | DN-01                          |            |            | Linear Modal Hist | CP-FYhis | 1           |
| 59 | DN-01                          |            |            | Linear Modal Hist | CP-MZhis | 1           |
| 60 | DN-01                          |            |            | Linear Modal Hist | CS-FYhis | 1           |
| 61 | DN-01                          |            |            | Linear Modal Hist | CS-MZhis | 1           |
| 62 | DN-01                          |            |            | Linear Modal Hist | M-his    | 1           |
| 63 | DN-EQ-01                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 64 | DN-EQ-01                       |            |            | Linear Static     | LIVE     | 0.75        |
| 65 | DN-EQ-01                       |            |            | Linear Static     | OPER     | 0.75        |
| 66 | DN-EQ-01                       |            |            | Linear Modal Hist | CP-FYhis | 0.75        |
| 67 | DN-EQ-01                       |            |            | Linear Modal Hist | CP-MZhis | 0.75        |
| 68 | DN-EQ-01                       |            |            | Linear Modal Hist | CS-FYhis | 0.75        |
| 69 | DN-EQ-01                       |            |            | Linear Modal Hist | CS-MZhis | 0.75        |
| 70 | DN-EQ-01                       |            |            | Linear Modal Hist | M-his    | 0.75        |
| 71 | DN-EQ-01                       |            |            | Linear Static     | EQX      | 0.75        |

|                                                                                            |                                                                                                                                       |           |           |         |      |          |       |                                                                                     |      |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|------|
| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p> |           |           |         |      |          |       |  |      |
| شماره پیمان:                                                                               | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                       |           |           |         |      |          |       | شماره صفحه : 16 از 30                                                               |      |
| 053 – 073 – 9184                                                                           | پروژه                                                                                                                                 | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     | نسخه |
|                                                                                            | BK                                                                                                                                    | GCS       | PEDCO     | 120     | ST   | CN       | 0006  |                                                                                     | D01  |

| 1   | TABLE: Combination Definitions |            |            |                   |          |             |
|-----|--------------------------------|------------|------------|-------------------|----------|-------------|
| 2   | ComboName                      | ComboType  | AutoDesign | CaseType          | CaseName | ScaleFactor |
| 3   | Text                           | Text       | Yes/No     | Text              | Text     | Unitless    |
| 72  | DN-EQ-02                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 73  | DN-EQ-02                       |            |            | Linear Static     | LIVE     | 0.75        |
| 74  | DN-EQ-02                       |            |            | Linear Static     | OPER     | 0.75        |
| 75  | DN-EQ-02                       |            |            | Linear Modal Hist | CP-FYhis | 0.75        |
| 76  | DN-EQ-02                       |            |            | Linear Modal Hist | CP-MZhis | 0.75        |
| 77  | DN-EQ-02                       |            |            | Linear Modal Hist | CS-FYhis | 0.75        |
| 78  | DN-EQ-02                       |            |            | Linear Modal Hist | CS-MZhis | 0.75        |
| 79  | DN-EQ-02                       |            |            | Linear Modal Hist | M-his    | 0.75        |
| 80  | DN-EQ-02                       |            |            | Linear Static     | EQX      | -0.75       |
| 81  | DN-EQ-03                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 82  | DN-EQ-03                       |            |            | Linear Static     | LIVE     | 0.75        |
| 83  | DN-EQ-03                       |            |            | Linear Static     | OPER     | 0.75        |
| 84  | DN-EQ-03                       |            |            | Linear Modal Hist | CP-FYhis | 0.75        |
| 85  | DN-EQ-03                       |            |            | Linear Modal Hist | CP-MZhis | 0.75        |
| 86  | DN-EQ-03                       |            |            | Linear Modal Hist | CS-FYhis | 0.75        |
| 87  | DN-EQ-03                       |            |            | Linear Modal Hist | CS-MZhis | 0.75        |
| 88  | DN-EQ-03                       |            |            | Linear Modal Hist | M-his    | 0.75        |
| 89  | DN-EQ-03                       |            |            | Linear Static     | EQY      | 0.75        |
| 90  | DN-EQ-04                       | Linear Add | No         | Linear Static     | DEAD     | 0.75        |
| 91  | DN-EQ-04                       |            |            | Linear Static     | LIVE     | 0.75        |
| 92  | DN-EQ-04                       |            |            | Linear Static     | OPER     | 0.75        |
| 93  | DN-EQ-04                       |            |            | Linear Modal Hist | CP-FYhis | 0.75        |
| 94  | DN-EQ-04                       |            |            | Linear Modal Hist | CP-MZhis | 0.75        |
| 95  | DN-EQ-04                       |            |            | Linear Modal Hist | CS-FYhis | 0.75        |
| 96  | DN-EQ-04                       |            |            | Linear Modal Hist | CS-MZhis | 0.75        |
| 97  | DN-EQ-04                       |            |            | Linear Modal Hist | M-his    | 0.75        |
| 98  | DN-EQ-04                       |            |            | Linear Static     | EQY      | -0.75       |
| 99  | DN-FATG                        | Linear Add | No         | Linear Static     | DEAD     | 1           |
| 100 | DN-FATG                        |            |            | Linear Static     | LIVE     | 1           |
| 101 | DN-FATG                        |            |            | Linear Static     | OPER     | 1           |
| 102 | DN-FATG                        |            |            | Linear Modal Hist | CP-FYhis | 3           |
| 103 | DN-FATG                        |            |            | Linear Modal Hist | CP-MZhis | 3           |
| 104 | DN-FATG                        |            |            | Linear Modal Hist | CS-FYhis | 3           |
| 105 | DN-FATG                        |            |            | Linear Modal Hist | CS-MZhis | 3           |

| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>                                                                                                                                                                                                      |  |      |         |            |           |       |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                       |
|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|------------|-----------|-------|--|--|------|-------|----------|------|---------|------------|-----------|-------|-----|------|----|----|-----|-------|-----|----|-----------------------|
| شماره پیمان:<br>053-073-9184                                                               | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادر کننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |            |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادر کننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 17 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                            |                                                                                     |      |         |            |           |       |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                       |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                      | نوع مدرک                                                                            | رشته | تسهیلات | صادر کننده | بسته کاری | پروژه |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                       |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                       | CN                                                                                  | ST   | 120     | PEDCO      | GCS       | BK    |  |  |      |       |          |      |         |            |           |       |     |      |    |    |     |       |     |    |                       |

|     |                                       |                  |                   |                   |                 |                    |
|-----|---------------------------------------|------------------|-------------------|-------------------|-----------------|--------------------|
| 1   | <b>TABLE: Combination Definitions</b> |                  |                   |                   |                 |                    |
| 2   | <b>ComboName</b>                      | <b>ComboType</b> | <b>AutoDesign</b> | <b>CaseType</b>   | <b>CaseName</b> | <b>ScaleFactor</b> |
| 3   | <b>Text</b>                           | <b>Text</b>      | <b>Yes/No</b>     | <b>Text</b>       | <b>Text</b>     | <b>Unitless</b>    |
| 106 | DN-FATG                               |                  |                   | Linear Modal Hist | M-his           | 3                  |
| 107 | VIBRATION                             | Linear Add       | No                | Linear Modal Hist | CP-FYhis        | 1                  |
| 108 | VIBRATION                             |                  |                   | Linear Modal Hist | CP-MZhis        | 1                  |
| 109 | VIBRATION                             |                  |                   | Linear Modal Hist | CS-FYhis        | 1                  |
| 110 | VIBRATION                             |                  |                   | Linear Modal Hist | CS-MZhis        | 1                  |
| 111 | VIBRATION                             |                  |                   | Linear Modal Hist | M-his           | 1                  |

## 6.0 CALCULATION OF STIFFNESS:

|                              |  |                                                                    |      |            |            |               |       |  |  |
|------------------------------|--|--------------------------------------------------------------------|------|------------|------------|---------------|-------|--|--|
| 2-1-EQUIVALENT RADII:        |  |                                                                    |      |            |            |               |       |  |  |
| Translational :              |  | $R_z=R_x=R_y= (a.b/\pi)^{1/2}$                                     |      | =          | 5.94       | m             |       |  |  |
| Rocking (About "X" axis) :   |  | $R_\psi= (b^3.a/3\pi)^{1/4}$                                       |      | =          | 5.83       | m             |       |  |  |
| Pitching (About "Y" axis) :  |  | $R_\phi= (a^3.b/3\pi)^{1/4}$                                       |      | =          | 6.20       | m             |       |  |  |
| Torsion (About "Z" axis) :   |  | $R_\theta= (a.b(a^2+ b^2)/6\pi)^{1/4}$                             |      | =          | 6.02       | m             |       |  |  |
| 2-2-EMBEDMENT COEFFICIENTS : |  |                                                                    |      |            |            |               |       |  |  |
| Vertical :                   |  | $\eta_z= 1+0.6(1-\nu)(Heff/R_z)$                                   |      |            |            | 1.000         |       |  |  |
| Horizontal :                 |  | $\eta_x= 1+0.55(2-\nu)(Heff/R_x)$                                  |      |            |            | 1.000         |       |  |  |
| Horizontal :                 |  | $\eta_y= 1+0.55(2-\nu)(Heff/R_y)$                                  |      |            |            | 1.000         |       |  |  |
| Rocking (About "X" axis) :   |  | $\eta_\psi= 1+1.2(1-\nu)(Heff/R_\psi) + 0.2(2-\nu)(Heff/R_\psi)^3$ |      |            |            | 1.000         |       |  |  |
| Pitching (About "Y" axis) :  |  | $\eta_\phi= 1+1.2(1-\nu)(Heff/R_\phi) + 0.2(2-\nu)(Heff/R_\phi)^3$ |      |            |            | 1.000         |       |  |  |
| Torsion (About "Z" axis) :   |  | $\eta_\theta=$ Not yet available in this version                   |      |            |            |               |       |  |  |
| 2-3-STIFFNESSES :            |  |                                                                    |      |            |            |               |       |  |  |
| Vertical :                   |  | a=                                                                 | 11.2 | m          | From table |               |       |  |  |
|                              |  | b=                                                                 | 9.9  | m          | →          | $\beta_z=$    | 2.141 |  |  |
| Horizontal :                 |  | a/b=                                                               | 1.13 | From table |            | $\beta_x=$    | 0.975 |  |  |
| Horizontal :                 |  | b/a=                                                               | 0.88 | →          |            | $\beta_y=$    | 1.000 |  |  |
| Rocking (About "X" axis) :   |  | b/a=                                                               | 0.88 | From table |            | $\beta_\psi=$ | 0.498 |  |  |
| Pitching (About "Y" axis) :  |  | a/b=                                                               | 1.13 | →          |            | $\beta_\phi=$ | 0.523 |  |  |

|                             |  |                                                |                  |            |
|-----------------------------|--|------------------------------------------------|------------------|------------|
| Vertical :                  |  | $K_z= G/(1-\nu).\beta_z(a.b)^{1/2}.\eta_z$     | 975587126.1      | kg.f/m     |
| Horizontal :                |  | $K_x= 2(1+\nu).G.\beta_x(a.b)^{1/2}.\eta_x$    | 791768759.4      | kg.f/m     |
| Horizontal :                |  | $K_y= 2(1+\nu).G.\beta_y(a.b)^{1/2}.\eta_y$    | 812280903.4      | kg.f/m     |
| Rocking (About "X" axis) :  |  | $K_\psi= G/(1-\nu).\beta_\psi.a.b^2.\eta_\psi$ | 23680093701.5    | kg.f.m/rad |
| Pitching (About "Y" axis) : |  | $K_\phi= G/(1-\nu).\beta_\phi.a^2.\eta_\phi$   | 28119341850.7    | kg.f.m/rad |
| Torsion (About "Z" axis) :  |  | $a_0= R_\theta \omega_m(\rho/G)^{0.5}$         | $\omega_m= 44.4$ |            |
|                             |  | $a_0= 0.69$                                    |                  |            |
|                             |  | $A= 1-0.425*(0.687a_0)^2/(1+0.687a_0)^2$       |                  |            |
|                             |  | $A= 0.921$                                     |                  |            |
|                             |  | $K_\theta= 16A.G.R_\theta^3/3$                 | 31110283213.8    | kg.f.m/rad |

| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>                                                                                                                                                                                                     |  |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|-----------|-----------|-------|--|--|------|-------|----------|------|---------|-----------|-----------|-------|-----|------|----|----|-----|-------|-----|----|-----------------------|
| شماره پیمان:<br>053 - 073 - 9184                                                           | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |           |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 18 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک                                                                            | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                      | CN                                                                                  | ST   | 120     | PEDCO     | GCS       | BK    |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |

Compressor:

$$= 2572.17 Ix = \frac{1}{12} m (a^2 + b^2) = \frac{1}{12} * 6389.3(1.357^2 + 1.729^2)$$

$$= 13977.67 Iy = \frac{1}{12} m (a^2 + L^2) = \frac{1}{12} * 6389.3(1.357^2 + 4.935^2)$$

$$Iz = \frac{1}{12} m (b^2 + L^2) = \frac{1}{12} * 6389.3(1.729^2 + 4.935^2) = 14558.91$$

Motor :

$$= 4595.43 Ix = \frac{1}{12} m (a^2 + b^2) = \frac{1}{12} * 1785(4.994^2 + 2.440^2)$$

$$= 4838.85 Iy = \frac{1}{12} m (a^2 + L^2) = \frac{1}{12} * 1785(4.994^2 + 2.755^2)$$

$$Iz = \frac{1}{12} m (b^2 + L^2) = \frac{1}{12} * 1785(2.440^2 + 2.755^2) = 2014.61$$

Modified Stiffness:

Number of Joints : n=400

➤ Translational

$$kg/mKx = \frac{Kx}{n} = \frac{791768759}{400} = 1979422$$

$$kg/mKy = \frac{Ky}{n} = \frac{812280903}{400} = 2030702$$

$$kg/mKz = \frac{Kz}{n} = \frac{975587126}{400} = 2438967$$

➤ Rotational

$$A=11.2*9.9=111 \text{ m}^2$$

$$m^3Ix = \frac{LB^3}{12} = \frac{11.2*9.9^3}{12} = 906$$

$$m^3Iy = \frac{BL^3}{12} = \frac{9.9*11.2^3}{12} = 1160$$

$$kg/mKs = \frac{Kz}{A} = \frac{975587126}{111} = 8789073$$

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|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|------|----------|-------|------|--|--|-------|-----------|------------|---------|------|----------|-------|------|----|-----|-------|-----|----|----|------|-----|-----------------------|
| شماره پیمان:<br>053-073-9184                                                               | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>PEDCO</td><td>120</td><td>ST</td><td>CN</td><td>0006</td><td>D01</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |         |      |          |       |      |  |  | پروژه | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه | BK | GCS | PEDCO | 120 | ST | CN | 0006 | D01 | شماره صفحه : 19 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                            |                                                                                     |         |      |          |       |      |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| پروژه                                                                                      | بسته کاری                                                                                                                                                                                                                                                                                                                                  | صادر کننده                                                                          | تسهیلات | رشته | نوع مدرک | سریال | نسخه |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| BK                                                                                         | GCS                                                                                                                                                                                                                                                                                                                                        | PEDCO                                                                               | 120     | ST   | CN       | 0006  | D01  |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |

$$kg/mK_{sx} = \frac{K_x}{A} = \frac{791768759}{111} = 7133052$$

$$kg/mK_{sy} = \frac{K_y}{A} = \frac{812280903}{111} = 7317846$$

$$K\omega_x = \frac{[K\omega - K_s * I_x]}{n} = \frac{[23680093701 - 8789073 * 906]}{400} = 39292982 \text{ kg/m} \quad \text{Rocking Stiffness}$$

$$K\omega_y = \frac{[K\omega - K_s * I_y]}{n} = \frac{[28119341851 - 8789073 * 1160]}{400} = 44810040 \text{ kg/m} \quad \text{Pitching Stiffness}$$

$$K\omega_z = \frac{[K\omega - K_{sx} * I_x - K_{sy} * I_y]}{n} = \frac{[31720103715 - 7133052 * 906 - 7317846 * 1160]}{400} = 40397592 \text{ kg/m}$$

Torsional Stiffness

## 7.0 CHECKING AND RESULTS

### 7.1 Minimum Weight of Foundation

According to design criteria total foundation weight shall be at least 5 times the total machinery weight for Reciprocating Machines.

Foundation Weight (Include foundation, pedestal & compressor)= 675.15 ton

Compressor Weight= 81.745 ton

$$> 5 \quad \text{ok} \quad \sqrt{\frac{W_{\text{foundation}}}{W_{\text{compressor}}}} = \frac{675.15}{81.745} = 8.05$$

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|--------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|-----------|-----------|-------|--|--|------|-------|----------|------|---------|-----------|-----------|-------|-----|------|----|----|-----|-------|-----|----|-----------------------|
| شماره پیمان:<br>053 - 073 - 9184                                                           | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |           |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 20 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| نسخه                                                                                       | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک                                                                            | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| D01                                                                                        | 0006                                                                                                                                                                                                                                                                                                                                      | CN                                                                                  | ST   | 120     | PEDCO     | GCS       | BK    |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |

## 7.2 Resonance Control



$$\frac{f_{\text{machine}}}{f_{\text{natural}}} > 1.4 \quad \text{or} \quad \frac{f_{\text{machine}}}{f_{\text{natural}}} < 0.7$$

CHECK FOR RESONANCE POSSIBILITY :

| OSCILLATION MODE              | fn(r.p.m.) | D <sub>i</sub> | fm(r.p.m.)=fn(1-2D <sub>i</sub> <sup>2</sup> ) <sup>0.5</sup> | RESULTS            |
|-------------------------------|------------|----------------|---------------------------------------------------------------|--------------------|
| Vertical (in "Z" direction)   | 1209.2     | 0.500          | 855.0                                                         | RESONANCE POSSIBLE |
| Horizontal (in "X" direction) | 1089.4     | 0.200          | 1044.9                                                        | RESONANCE POSSIBLE |
| Horizontal (in "Y" direction) | 1103.4     | 0.200          | 1058.3                                                        | RESONANCE POSSIBLE |
| Rocking (about "X" axis)      | 1449.0     | 0.200          | 1389.8                                                        | RESONANCE POSSIBLE |
| Pitching (about "Y" axis)     | 1668.9     | 0.100          | 1652.1                                                        | RESONANCE POSSIBLE |
| Torsion (about "Z" axis)      | 1341.6     | 0.150          | 1311.1                                                        | RESONANCE POSSIBLE |

f<sub>p</sub>= 367.5 r.p.m. Primary frequency

FR<sub>L</sub>.f<sub>p</sub>= 257.3 r.p.m. lower limit for resonance frequency

FR<sub>U</sub>.f<sub>p</sub>= 477.8 r.p.m. upper limit for resonance frequency

Resonant frequency should be in this range :

f<sub>m</sub> <= 257.3 r.p.m OR f<sub>m</sub> >= 477.8 r.p.m

| OSCILLATION MODE              | fm(r.p.m.) | RESULTS                                          |
|-------------------------------|------------|--------------------------------------------------|
| Vertical (in "Z" direction)   | 855.0      | natural frequency is not in resonance range O.K. |
| Horizontal (in "X" direction) | 1044.9     | natural frequency is not in resonance range O.K. |
| Horizontal (in "Y" direction) | 1058.3     | natural frequency is not in resonance range O.K. |
| Rocking (about "X" axis)      | 1389.8     | natural frequency is not in resonance range O.K. |
| Pitching (about "Y" axis)     | 1652.1     | natural frequency is not in resonance range O.K. |
| Torsion (about "Z" axis)      | 1311.1     | natural frequency is not in resonance range O.K. |

## 7.3 Rotation & Displacement Control:

$$F_{Z(\text{Total})} = F_{\text{primary}} + F_{\text{secondary}}$$

$$F_{X(\text{Total})} = F_{\text{primary}} + F_{\text{secondary}}$$

$$F_{Y(\text{Total})} = F_{\text{primary}} + F_{\text{secondary}}$$

$$M_{\psi(\text{Total})} = M_{\psi(\text{primary})} + M_{\psi(\text{secondary})} + F_{Y(\text{total})} * H_t + F_{Z(\text{total})} * e_y \text{ (Rocking about X)}$$

$$M_{\phi(\text{Total})} = M_{\phi(\text{primary})} + M_{\phi(\text{secondary})} + F_{X(\text{total})} * H_t + F_{Z(\text{total})} * e_x \text{ (Pitching about Y)}$$

$$M_{\theta(\text{Total})} = M_{\theta(\text{primary})} + M_{\theta(\text{secondary})} + F_{X(\text{total})} * e_y + F_{Y(\text{total})} * e_x \text{ (Torsion about Z)}$$

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|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|------|----------|-------|------|--|--|-------|-----------|------------|---------|------|----------|-------|------|----|-----|-------|-----|----|----|------|-----|-----------------------|
| شماره پیمان:<br>053 - 073 - 9184                                                           | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>PEDCO</td><td>120</td><td>ST</td><td>CN</td><td>0006</td><td>D01</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |         |      |          |       |      |  |  | پروژه | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه | BK | GCS | PEDCO | 120 | ST | CN | 0006 | D01 | شماره صفحه : 21 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                            |                                                                                     |         |      |          |       |      |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| پروژه                                                                                      | بسته کاری                                                                                                                                                                                                                                                                                                                                  | صادر کننده                                                                          | تسهیلات | رشته | نوع مدرک | سریال | نسخه |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| BK                                                                                         | GCS                                                                                                                                                                                                                                                                                                                                        | PEDCO                                                                               | 120     | ST   | CN       | 0006  | D01  |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |



### Control I:

Transitional Ocilation modes:  $\delta_i = \frac{(DMF)_i \cdot F_i}{K_i}$

Rotational Ocilation modes:  $\alpha_i = \frac{(DMF)_i \cdot M_i}{K_{\alpha i}}$

$$\delta_{Z(total)} = \delta_z + (X_t^* \phi + y_t^* \psi)$$

$$\delta_{x(total)} = \delta_x + (Z_t^* \phi + y_t^* \theta)$$

$$\delta_{y(total)} = \delta_y + (Z_t^* \psi + x_t^* \theta)$$

$x_t, y_t, Z_t$  : Target Points in 3 Directions

At Target Point :  $\delta_{max} < 25 \mu m$  (or vendor)

### Control II:

$$V_{max.x} = \sum \delta_{max.x} \cdot \omega_i \quad (i=1, \dots, n)$$

$$V_{max.y} = \sum \delta_{max.y} \cdot \omega_i \quad (i=1, \dots, n)$$

$$V_{max.z} = \sum \delta_{max.z} \cdot \omega_i \quad (i=1, \dots, n)$$

$$V_{resultant} = \sqrt{(V_{max.x})^2 + (V_{max.y})^2 + (V_{max.z})^2} < 2.0 \text{ mm/s (or vendor)}$$

### Control III:

➤  $Q_{dyn}$

$$F_{Z(base)} = F_z \cdot T_{rz}$$

$$M_{x(base)} = M_x \cdot T_{rx}$$

$$M_{y(base)} = M_y \cdot T_{ry}$$

$$Q_{dyn} = \frac{F_z}{BL} + \frac{6M_x}{LB^2} + \frac{6M_y}{BL^2} = \frac{0.35}{11.2 \cdot 9.9} + \frac{6 \cdot 24.6}{11.2 \cdot 9.9^2} + \frac{6 \cdot 5}{9.9 \cdot 11.2^2} = 0.16 \text{ ton/m}^2$$

➤  $Q_{stat}$ :

$$q_{max} = \frac{W_{Total}}{L \cdot B} \left( 1 + \frac{6M_x}{B \cdot L^2} + \frac{6M_y}{L \cdot B^2} \right) = \frac{W_{Total}}{L \cdot B} \left( 1 + \frac{6e_x}{L} + \frac{6e_y}{B} \right) = \frac{648.5}{11.2 \cdot 9.9} \left( 1 + \frac{6 \cdot 0.663}{11.2} + \frac{6 \cdot 0.971}{9.9} \right) = 10.67 \text{ ton/m}^2$$

$$q_{min} = \frac{W_{Total}}{L \cdot B} \left( 1 - \frac{6M_x}{B \cdot L^2} - \frac{6M_y}{L \cdot B^2} \right) = \frac{W_{Total}}{L \cdot B} \left( 1 - \frac{6e_x}{L} - \frac{6e_y}{B} \right) = \frac{648.5}{11.2 \cdot 9.9} \left( 1 - \frac{6 \cdot 0.663}{11.2} - \frac{6 \cdot 0.971}{9.9} \right) = 0.31 \text{ ton/m}^2$$

$$W_{Total} = W_{found.} + W_{ped.} + W_{machine} = 648.5 \text{ ton}$$

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|--------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|---------|------|----------|-------|------|--|--|-------|-----------|------------|---------|------|----------|-------|------|----|-----|-------|-----|----|----|------|-----|-----------------------|
| شماره پیمان:<br>053 - 073 - 9184                                                           | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>پروژه</th><th>بسته کاری</th><th>صادر کننده</th><th>تسهیلات</th><th>رشته</th><th>نوع مدرک</th><th>سریال</th><th>نسخه</th></tr><tr><td>BK</td><td>GCS</td><td>PEDCO</td><td>120</td><td>ST</td><td>CN</td><td>0006</td><td>D01</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |         |      |          |       |      |  |  | پروژه | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه | BK | GCS | PEDCO | 120 | ST | CN | 0006 | D01 | شماره صفحه : 22 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                            |                                                                                                                                                                                                                                                                                                                                            |                                                                                     |         |      |          |       |      |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| پروژه                                                                                      | بسته کاری                                                                                                                                                                                                                                                                                                                                  | صادر کننده                                                                          | تسهیلات | رشته | نوع مدرک | سریال | نسخه |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |
| BK                                                                                         | GCS                                                                                                                                                                                                                                                                                                                                        | PEDCO                                                                               | 120     | ST   | CN       | 0006  | D01  |  |  |       |           |            |         |      |          |       |      |    |     |       |     |    |    |      |     |                       |



$$q_{dyn.} + q_{stat.} < 0.75 \cdot q_{all}$$

$$q_{max} = q_{stat.max} + q_{dyn.} = 10.67 + 0.16 = 10.83 \text{ ton/m}^2 < 15 \text{ ton/m}^2$$

$$q_{min} = q_{stat.min} - q_{dyn.} = 0.31 - 0.16 = 0.15 \text{ ton/m}^2 \rightarrow \text{no uplift} \quad \text{ok} \checkmark$$

#### 7.4 Overturning Control :

- $W_m$  = Totally weight of machine = 81,743 kg
- $W_f$  = Totally weight of foundation =  $(11.2 \times 9.9 \times 1.9) \times 2500 = 526,680 \text{ kg}$
- $W_p$  = Totally weight of pedestal =  $(2.9 \times 4.5 \times 1.22) \times 2500 = 39,802.5 \text{ kg}$

$$W_T = \text{Total Weight} = 648,225.5 \text{ kg}$$

$$M_R = \text{Resistance Moment} = 648,225.5 \times \frac{11.2}{2} = 3,630,063 \text{ kg.m}$$

$$V = \text{Totally lateral load} = (0.25W_m + 0.263W_m) = 0.513 \times 81,743 = 41,934 \text{ kg}$$

$$M_a = \text{Active Moment} = 41,934 \times (1.9 + 1.22) = 130,834.5 \text{ kg.m}$$

$$\text{Safety Factor}_{\text{overturning}} = \frac{M_R}{M_a} = 27.75 > 3 \quad \text{ok} \checkmark$$

#### 7.5 Sliding Control :

$$V = \text{Active lateral load} = (0.25W_m + 0.263W_m) = 0.513 \times 81,743 = 41,934 \text{ kg}$$

$$W_T = \text{Total Vertical Load} = 648,225.5 \text{ kg}$$

$$\text{Safety Factor}_{\text{sliding}} = \frac{W_T \cdot \mu}{V}, \quad \mu = \text{coefficient of friction}$$

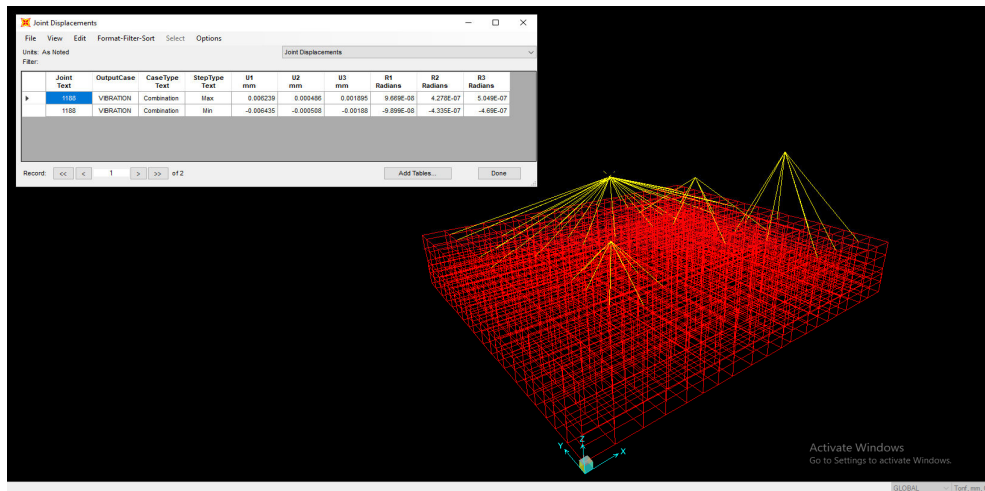
$$\text{Safety Factor}_{\text{sliding}} = \frac{W_T \cdot \tan\left(\frac{2}{3} \cdot \phi\right)}{V} = \frac{648225.5 \times 0.36}{41934} = 5.56 > 1.5 \quad \text{ok} \checkmark$$

|                                                                                            |                                                                                                                                    |           |            |         |      |          |       |                                                                                     |                       |
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| شماره پیمان:<br>053-073-9184                                                               | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                    |           |            |         |      |          |       |                                                                                     | شماره صفحه : 23 از 30 |
|                                                                                            | پروژه                                                                                                                              | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال | نسخه                                                                                |                       |
|                                                                                            | BK                                                                                                                                 | GCS       | PEDCO      | 120     | ST   | CN       | 0006  | D01                                                                                 |                       |



## 7.6 Displcement Control :

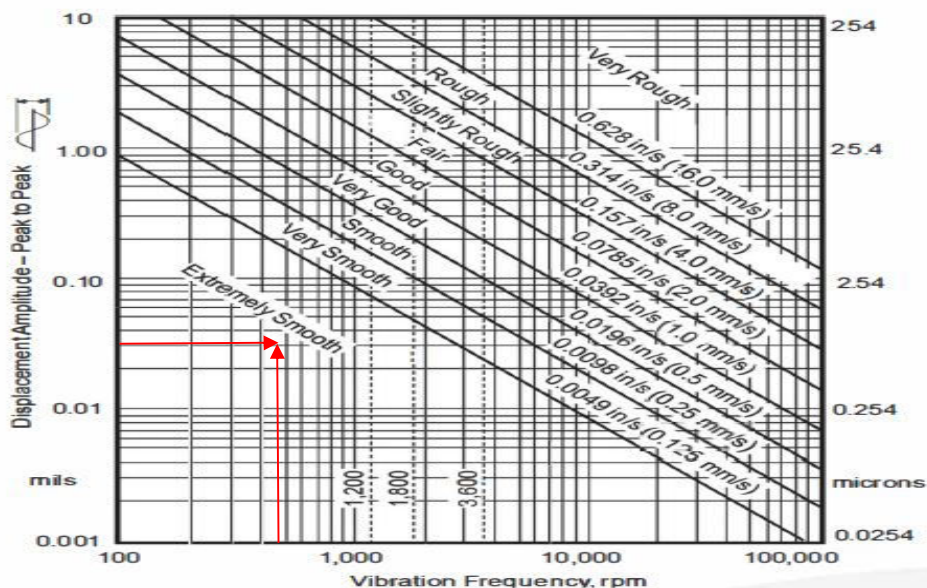
For compressor:



$$\delta_{\max x} = 0.00643 \text{ mm} \rightarrow \frac{\delta_{\max}}{25.4 \text{ mm}} = \frac{0.00643}{25.4} = 0.0025$$

$$\delta_{\max y} = 0.0005 \text{ mm} \rightarrow \frac{\delta_{\max}}{25.4 \text{ mm}} = \frac{0.0005}{25.4} = 0.0002, \quad \omega = 424 \text{ rpm}$$

According to ACI 351-3R.18 :



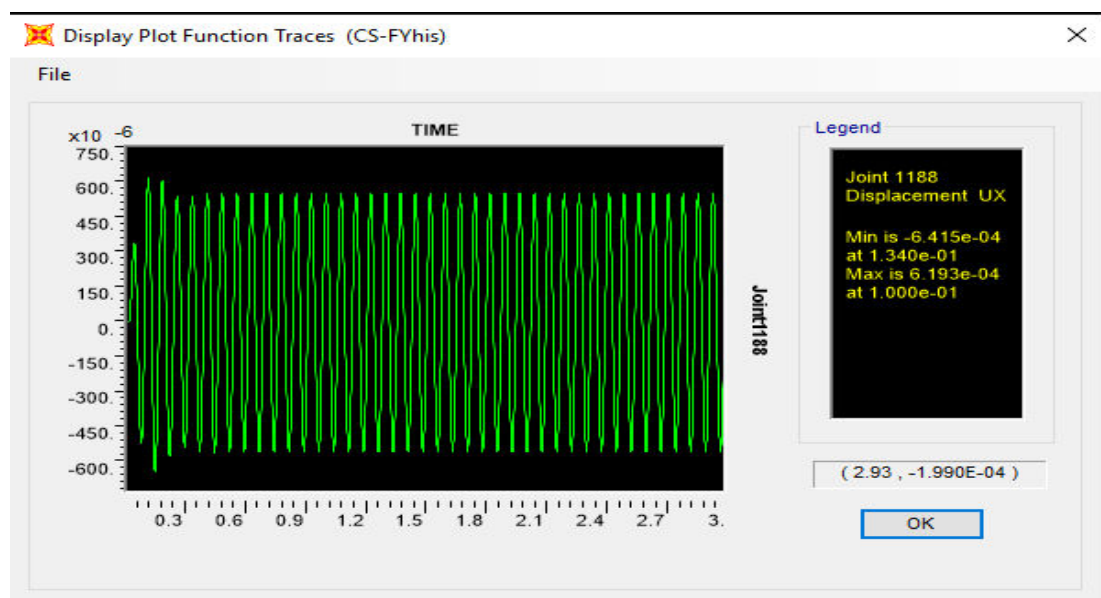
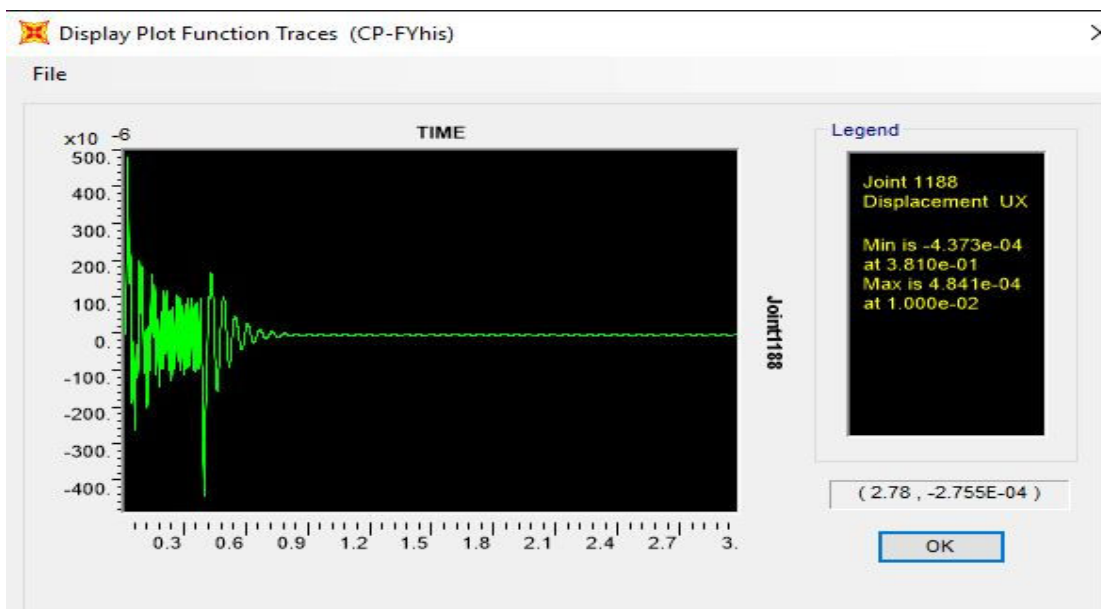
above graph indicate that maximum of displacement is acceptable.

| <br><b>NISOC</b> | <p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>                                                                                                                                                                                                     |  |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------|------|---------|-----------|-----------|-------|--|--|------|-------|----------|------|---------|-----------|-----------|-------|-----|------|----|----|-----|-------|-----|----|-----------------------|
| شماره پیمان:<br>053-073-9184                                                                      | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |      |         |           |           |       |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 24 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                   |                                                                                                                                                                                                                                                                                                                                           |                                                                                     |      |         |           |           |       |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| نسخه                                                                                              | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک                                                                            | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| D01                                                                                               | 0006                                                                                                                                                                                                                                                                                                                                      | CN                                                                                  | ST   | 120     | PEDCO     | GCS       | BK    |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |



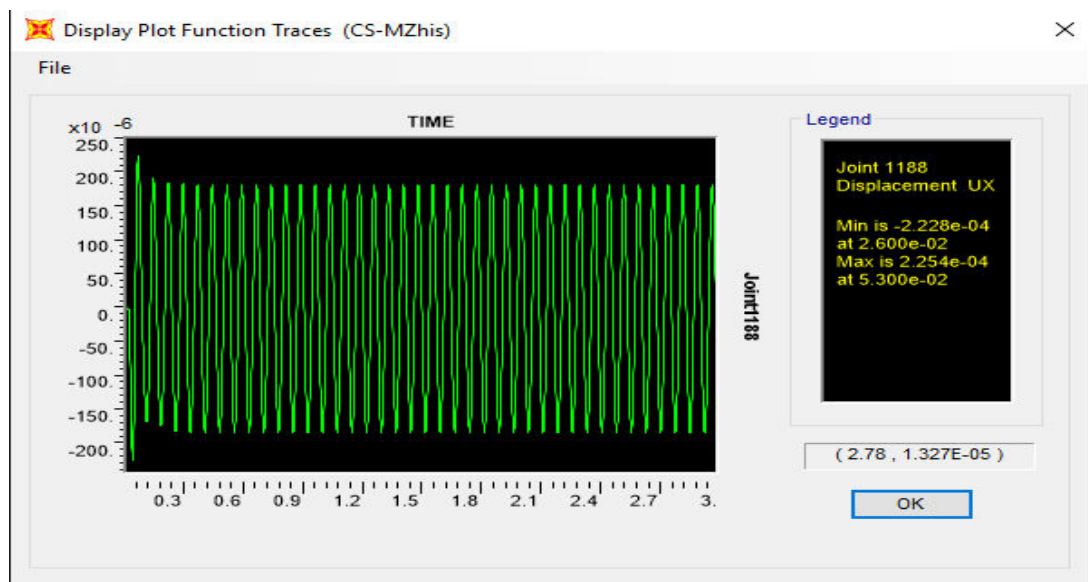
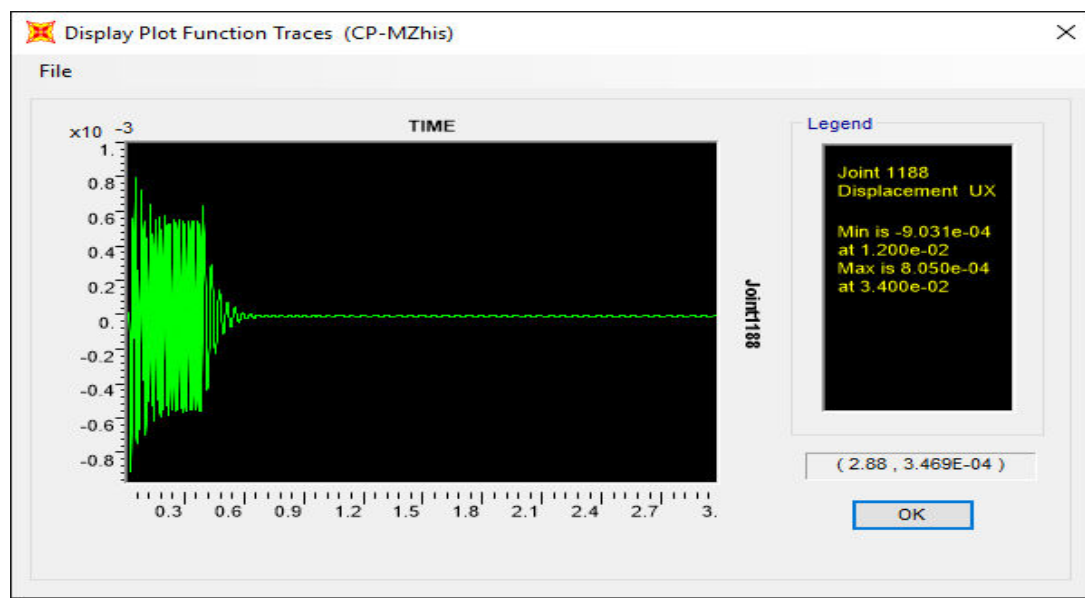
The following graphs also show that the maximum displacements in the vibration load combination are larger than the individual time history loadings.

Max displacement  $U_x$ (mm):

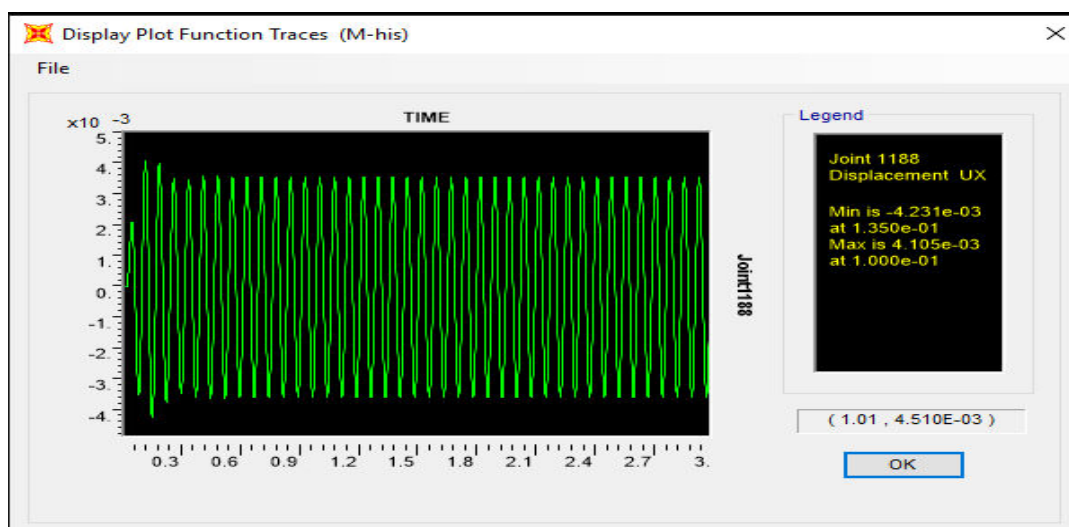


| <br><b>NISOC</b> | <p>نگهداشت و افزایش تولید میدان نفتی بینک<br/>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p>                                                                                                                                                                                                        |          |      |         |           |           |       |  |  |  |  |  |  |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
|---------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|------|---------|-----------|-----------|-------|-------------------------------------------------------------------------------------|--|--|--|--|--|--|--|------|-------|----------|------|---------|-----------|-----------|-------|-----|------|----|----|-----|-------|-----|----|-----------------------|
| شماره پیمان:<br>053 – 073 – 9184                                                                  | <table><tr><th colspan="8">CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION</th></tr><tr><th>نسخه</th><th>سریال</th><th>نوع مدرک</th><th>رشته</th><th>تسهیلات</th><th>صادرکننده</th><th>بسته کاری</th><th>پروژه</th></tr><tr><td>D01</td><td>0006</td><td>CN</td><td>ST</td><td>120</td><td>PEDCO</td><td>GCS</td><td>BK</td></tr></table> |          |      |         |           |           |       | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                     |  |  |  |  |  |  |  | نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه | D01 | 0006 | CN | ST | 120 | PEDCO | GCS | BK | شماره صفحه : 25 از 30 |
| CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                   |                                                                                                                                                                                                                                                                                                                                           |          |      |         |           |           |       |                                                                                     |  |  |  |  |  |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| نسخه                                                                                              | سریال                                                                                                                                                                                                                                                                                                                                     | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |                                                                                     |  |  |  |  |  |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |
| D01                                                                                               | 0006                                                                                                                                                                                                                                                                                                                                      | CN       | ST   | 120     | PEDCO     | GCS       | BK    |                                                                                     |  |  |  |  |  |  |  |      |       |          |      |         |           |           |       |     |      |    |    |     |       |     |    |                       |

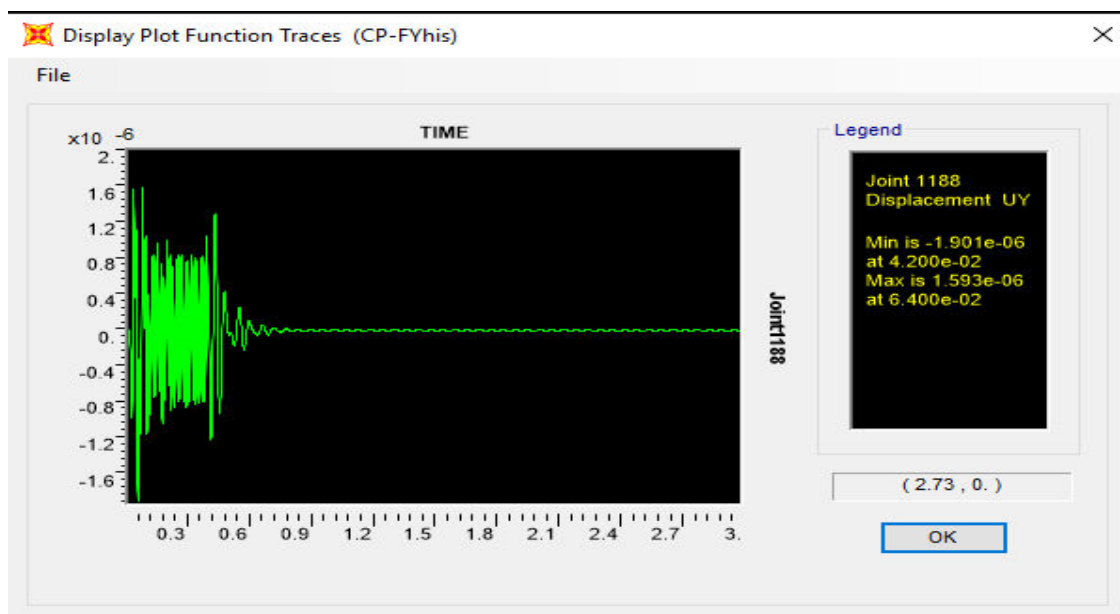
D01



|                                                                                            |                                                                                                                                       |           |           |         |      |          |       |                                                                                     |      |
|--------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|------|
| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک</p> <p>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p> |           |           |         |      |          |       |  |      |
| شماره پیمان:                                                                               | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                       |           |           |         |      |          |       | شماره صفحه : 26 از 30                                                               |      |
| 053-073-9184                                                                               | پروژه                                                                                                                                 | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     | نسخه |
|                                                                                            | BK                                                                                                                                    | GCS       | PEDCO     | 120     | ST   | CN       | 0006  |                                                                                     | D01  |

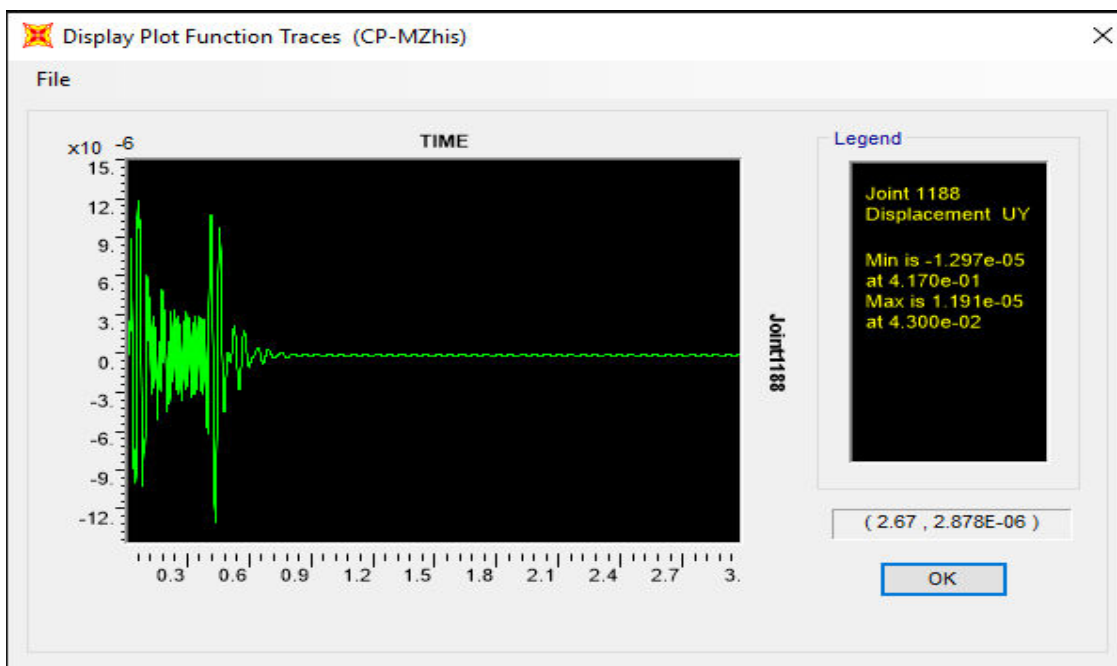
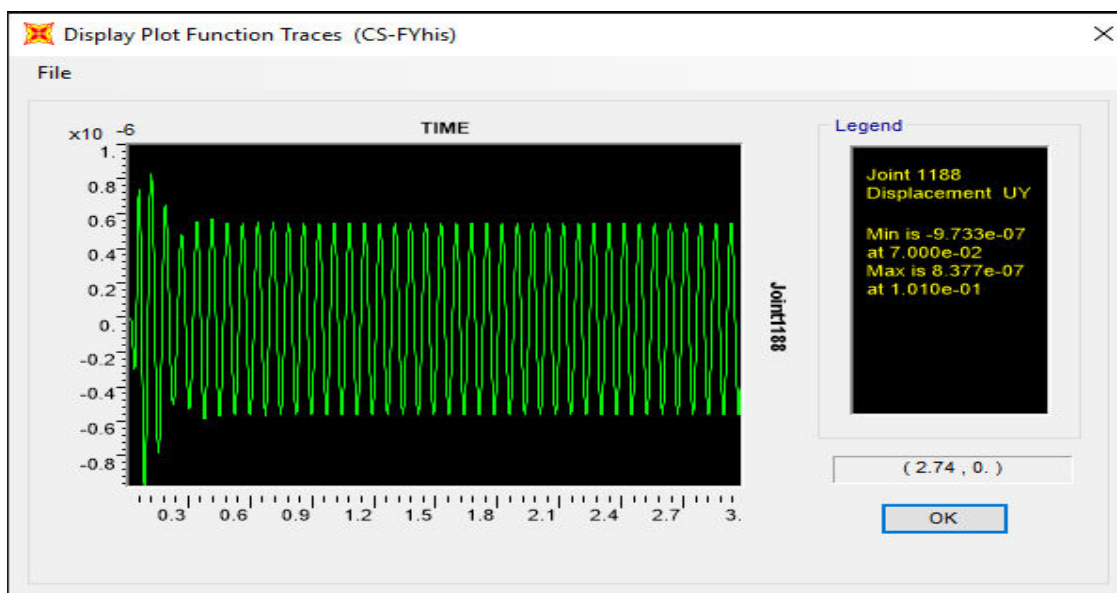


Max displacement Uy(mm):



|                                                                                            |                                                                                                                                    |           |           |         |      |          |       |                                                                                     |      |
|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|------|
| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک<br/>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p> |           |           |         |      |          |       |  |      |
| شماره پیمان:                                                                               | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                    |           |           |         |      |          |       | شماره صفحه : 27 از 30                                                               |      |
| 053 – 073 – 9184                                                                           | پروژه                                                                                                                              | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     | نسخه |
|                                                                                            | BK                                                                                                                                 | GCS       | PEDCO     | 120     | ST   | CN       | 0006  |                                                                                     | D01  |

D01





نگهداشت و افزایش تولید میدان نفتی بینک  
سطح الارض و ابنیه تحت الارض

احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک



شماره پیمان:

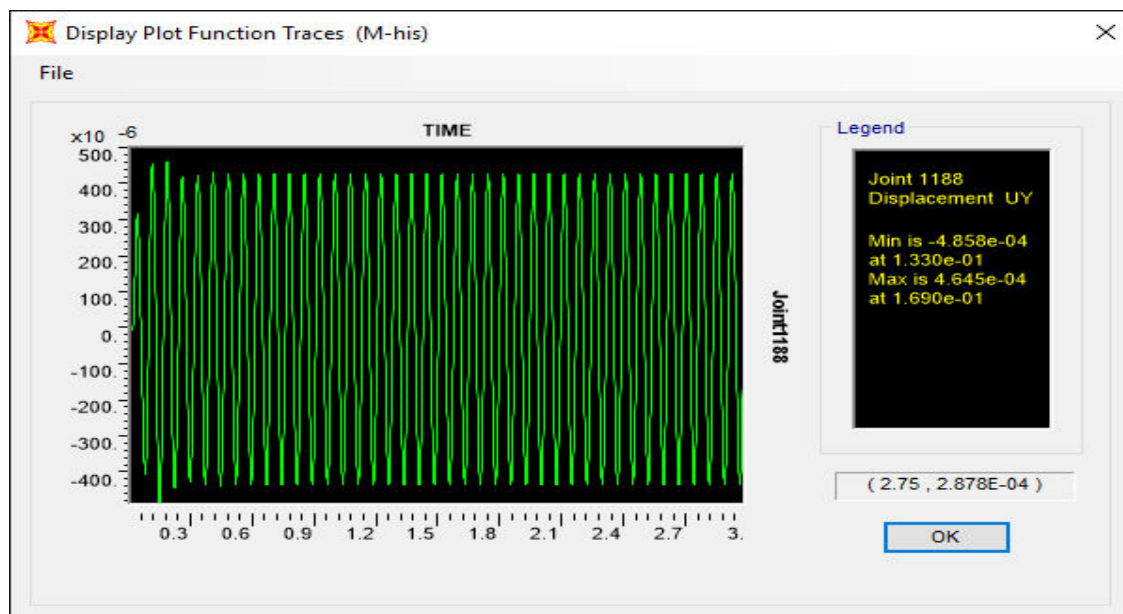
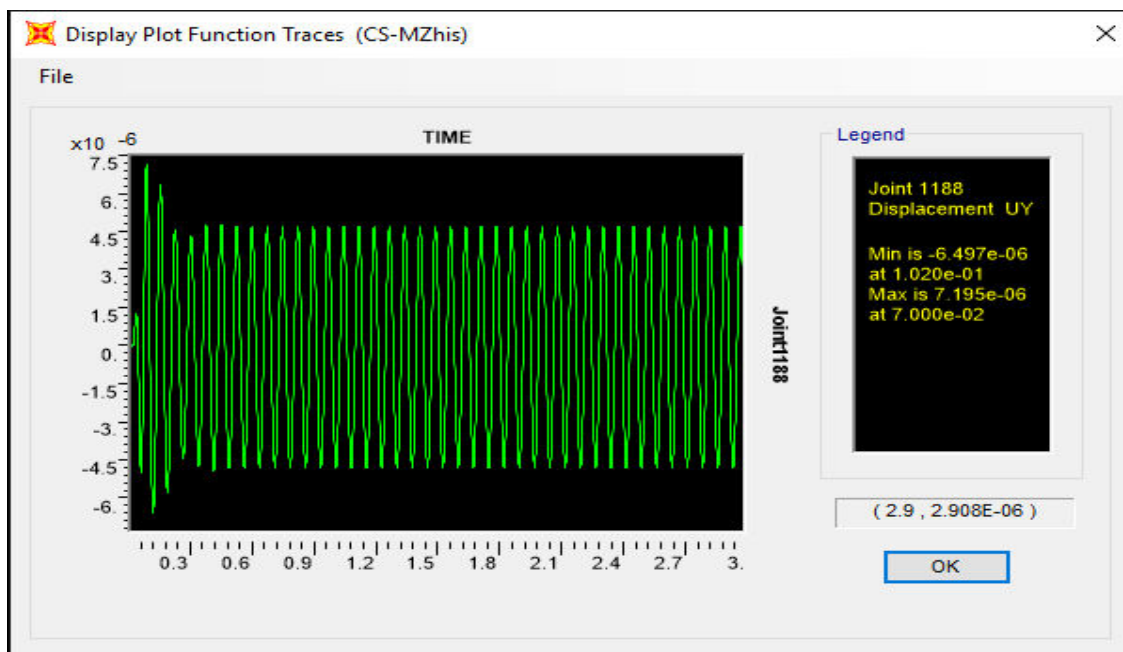
053-073-9184

CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION

| نسخه | سریال | نوع مدرک | رشته | تسهیلات | صادرکننده | بسته کاری | پروژه |
|------|-------|----------|------|---------|-----------|-----------|-------|
| D01  | 0006  | CN       | ST   | 120     | PEDCO     | GCS       | BK    |

شماره صفحه : 28 از 30

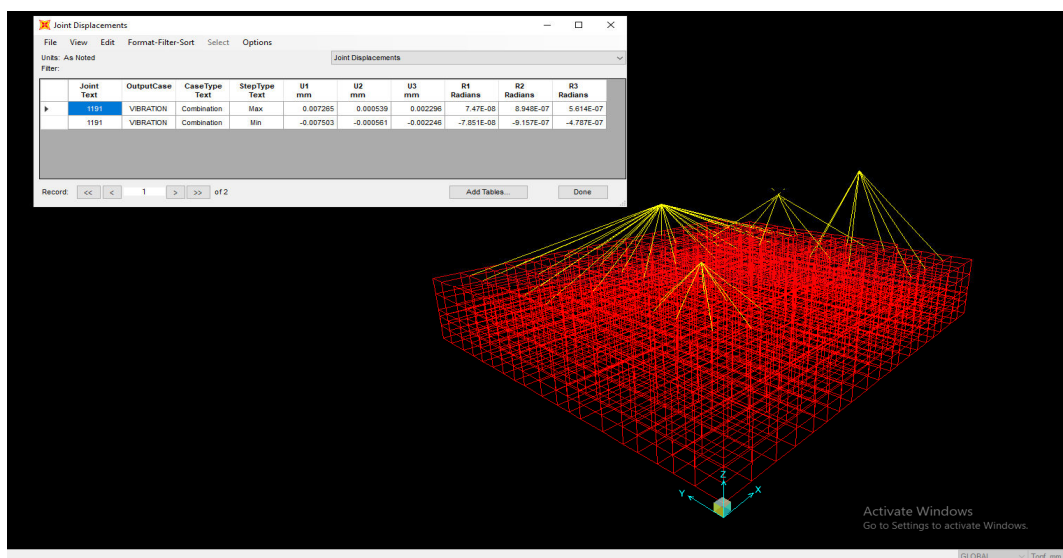
D01



|                                                                                            |                                                                                                                                    |           |            |         |      |          |       |                                                                                     |      |
|--------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------|------------|---------|------|----------|-------|-------------------------------------------------------------------------------------|------|
| <br>NISOC | <p>نگهداشت و افزایش تولید میدان نفتی بینک<br/>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p> |           |            |         |      |          |       |  |      |
| شماره پیمان:                                                                               | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                    |           |            |         |      |          |       | شماره صفحه : 29 از 30                                                               |      |
| 053 – 073 – 9184                                                                           | پروژه                                                                                                                              | بسته کاری | صادر کننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     | نسخه |
|                                                                                            | BK                                                                                                                                 | GCS       | PEDCO      | 120     | ST   | CN       | 0006  |                                                                                     | D01  |



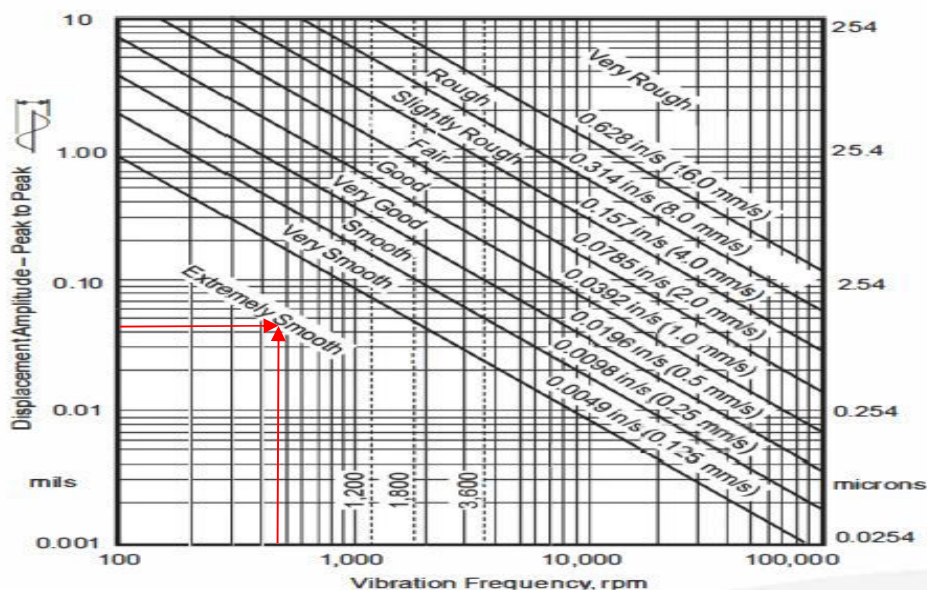
For Electrical Motor:



$$\delta \max x = 0.0075 \text{ mm} \rightarrow \frac{\delta \max}{25.4 \text{ mm}} = \frac{0.0075}{25.4} = 0.003$$

$$\delta \max y = 0.00056 \text{ mm} \rightarrow \frac{\delta \max}{25.4 \text{ mm}} = \frac{0.00056}{25.4} = 0.00022, \quad \omega = 424 \text{ rpm}$$

According to ACI 351-3R.18 :



above graph indicate that maximum of displacement is acceptable.

|                                                                                                   |                                                                                                                                    |           |           |         |      |          |       |                                                                                     |      |
|---------------------------------------------------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------|-----------|-----------|---------|------|----------|-------|-------------------------------------------------------------------------------------|------|
| <br><b>NISOC</b> | <p>نگهداشت و افزایش تولید میدان نفتی بینک<br/>سطح الارض و ابنیه تحت الارض</p> <p>احداث ردیف تراکم گاز در ایستگاه جمع آوری بینک</p> |           |           |         |      |          |       |  |      |
| شماره پیمان:                                                                                      | CALCULATION NOTE FOR GAS COMPRESSORS FOUNDATION                                                                                    |           |           |         |      |          |       | شماره صفحه : 30 از 30                                                               |      |
| 053 - 073 - 9184                                                                                  | پروژه                                                                                                                              | بسته کاری | صادرکننده | تسهیلات | رشته | نوع مدرک | سریال |                                                                                     | نسخه |
|                                                                                                   | BK                                                                                                                                 | GCS       | PEDCO     | 120     | ST   | CN       | 0006  |                                                                                     | D01  |



As mentioned for the compressor part as well the maximum displacements in the vibration load combination are larger than the individual time history loadings , However, the presentation of diagrams in this section has been omitted.

## 7.7 Foundation Design

The amount of reinforcement bar should be minimum 30 kg/m<sup>3</sup> for foundation.

The T16@200 reinforcement is used for the foundation for longitudinal & transversal footing (Top & Bottom) , so the amount of reinforcement is 9232 kg.

Also the volume of concrete is 226 m<sup>3</sup> and therefore the amount of reinforcement per unit volume is 41 kg/m<sup>3</sup> which is more than minimum amount.