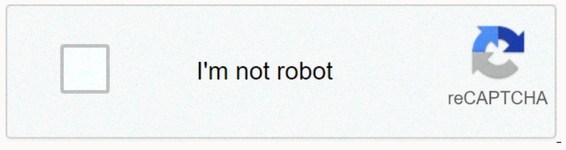
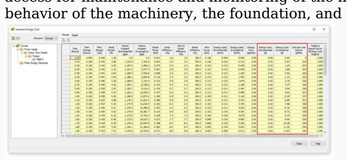


I'm not robot!

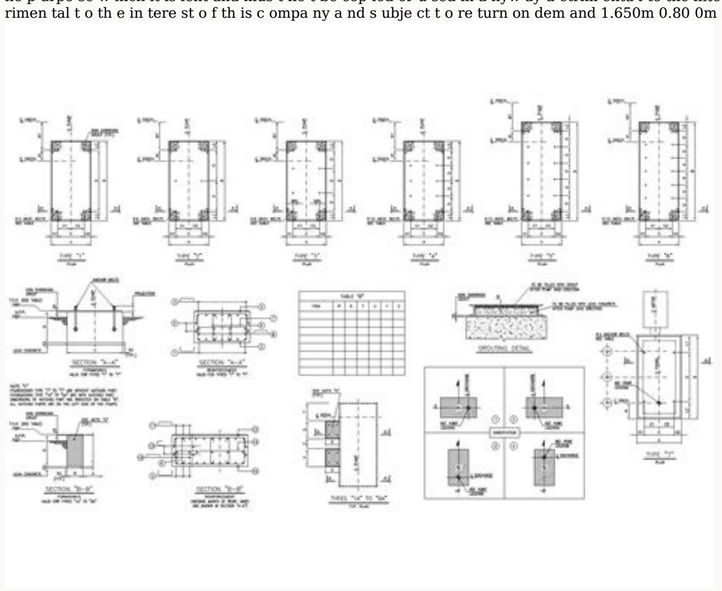
Pump foundation design spreadsheet

Pump foundation design example. Vertical pump foundation design example.

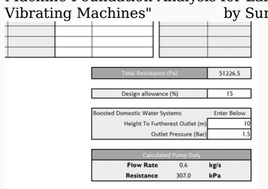
1 GENERAL DESIGN REQUIREMENTS 2 FOUNDATIONS AND STRUCTURES FOR VIBRATING MACHINERY 2.1 Scope 2.2 Definitions 2.3 Design criteria for all heavy machinery 2.4 Design criteria for reciprocating machinery 2.5 Design criteria for rotary machinery 2.6 Design criteria of light vibrating machinery 3 LOADING OF MACHINE FOUNDATIONS 3.1 Static loads 3.2 Rotating machine loads 3.3 Reciprocating machine loads 3.4 Impulsive machine loads 3.5 Loading conditions 3.4 Impulsive machine loads 3.5 Loading conditions Calculation ReferenceDesign for Machine Vibration FOUNDATIONS AND STRUCTURES FOR VIBRATING MACHINERY Rotating machine loads Foundations and structures for vibrating machinery are designed to support heavy machinery that generates vibrations during operation. These vibrations can cause structural damage, negatively impact the performance of the machinery, and transmit vibrations to nearby structures or the surrounding environment. To minimize these issues, special considerations must be taken into account when designing foundations and structures for vibrating machinery. Some key aspects to consider when designing foundations and structures for vibrating machinery include: Isolation: The foundation should be designed to isolate the vibrating machinery from the rest of the structure or adjacent structures. This can be achieved using various techniques, such as using isolators or pads made from materials that absorb vibrations, creating gaps between the machinery foundation and the surrounding structure, or constructing the foundation on a separate, isolated slab. Mass: The mass of the foundation should be sufficiently large to ensure stability and minimize the transmission of vibrations. A general rule of thumb is that the mass of the foundation should be 3 to 5 times the mass of the supported machinery. However, this ratio may vary depending on the specific machinery, soil conditions, and other factors. Stiffness: The foundation should be designed to have a high stiffness to prevent excessive deformation and movement under the dynamic loads generated by the machinery. This can be achieved by using reinforced concrete or other rigid materials and designing the foundation with appropriate dimensions and reinforcement. Damping: Damping is the ability of the foundation to dissipate the energy of vibrations. The foundation should be designed to provide adequate damping, either through the use of materials with inherent damping properties or by incorporating external damping devices, such as dampers or tuned mass dampers. Natural frequency: The natural frequency of the foundation and the supported structure should be considered during design. Ideally, the natural frequency of the foundation should be different from the dominant frequencies of the vibrating machinery to avoid resonance, which can amplify vibrations and cause structural damage. Soil properties: The properties of the soil, such as its bearing capacity, shear strength, and stiffness, must be considered when designing the foundation. The soil should be capable of supporting the combined static and dynamic loads generated by the machinery and the foundation. A geotechnical investigation may be necessary to determine the soil properties and select the appropriate foundation type, such as shallow or deep foundations. Maintenance and monitoring: The foundation should be designed with access for maintenance and monitoring of the machinery, as well as the foundation itself. Vibration sensors and other monitoring equipment may be installed to assess the performance of the foundation and identify potential issues. Designing foundations and structures for vibrating machinery requires a thorough understanding of the dynamic behavior of the machinery, the foundation, and the supporting soil. Various standards and guidelines, such as the International Building Code (IBC) or the American Concrete Institute (ACI) 351, provide recommendations for designing foundations and structures for vibrating machinery.



Engineers should also consult the manufacturer's recommendations and consider any site-specific conditions when designing the foundation. Thi s do cum ent is e xclu sive pro pert y of IO T D ES IGN & E NG INE ER ING Lim ited. It is t o be use d on ly f or t he p urpo se w hich it is lent and mus t no t be cop ied or u sed in a nyw ay d etrim enta l to the inte rest of this com pany and sub ject to retu rn o n de man d1.0 SCOPE 1.1 GENERAL DESCRIPTIONThe foundation has been checked for bearing pressure, buoyancy & soil pressure. 2.0 BASIC INFORMATION2.1 MATERIAL USED PCC M20 Thickness 75 mmConcrete Concrete grade shall be M30 with fck (characteristic strength, 28 days). = 30 Unit Weight of Concrete 2.5Reinforcement Steel: As per IS:1786, Grade Fe 415 with fy = 415Bar diameters used (mm) : 8, 10, 12, 16 2.2 SOIL PARAMETERS Assumed net SBC @Depth 1.5m for 2m x 2m foundation 3.5 Net bearing pressure (for seismic case) 4.375 Gross Bearing Pressure 9.109 Gross Bearing Pressure for seismic case 9.984 Unit Weight of Soil 1.8 2.3 CODES & STANDARDSPDRP-8310-DI-000-0001 - Civil/ Strucutral Design BasisIS456-2000 - Plane and Reinforced ConcreteIS2974-Part 4-1987 - Design Loads for Buildings and StructuresIS1893 (Part-1) -2002 - Criteria For Earthquake Resistant Design Of StructuresSP-16 - Design Aids for Reinforced Concrete to IS:456 2.4 INPUT DATA Foundation Data Width of pedestal, w 1.650 mDepth of pedestal, Hp 0.800 mLength of raft, L 2.000 mBreadth of raft, B 2.000 mDepth of Raft, Hr 0.300 mDia of shaft, D 0.995 mDepth of Shaft, Hs 3.616 mThickness of shaft wall, t 0.200 mClear Cover of Footing 50 mm Refer. 26.4.2.2 IS456-2000, 6.2 SP34-1987Clear Cover of Wall 45 mm Refer. Design BasisClear Cover of Slab 25 mm Refer. Design Basis ElevationsFinished Ground Level, FGL EL. 99.850Top Of Grout, TOG EL. 100.450Finished Floor Level, FFL EL. 100.300 Equipment DataWeight of Motor, Wm 1800 Kg Weight of Pump+barrel+sole plate, Wp 4700 Kg Total Weight of Pump system 6.50 TFrequency of Pump 1493 RpmTime period 0.040 secBar dia used 16 The scope of the present report is to analyse and design of pump foundation for vertical crude pump 205-P-027A/B/C at Paradip, Orissa N/mm2 gc T/m3 N/mm2 T/m2 T/m2 T/m2 T/m2 gs T/m3 Thi s do cum ent is e xclu sive pro pert y of IO T D ES IGN & E NG INE ER ING Lim ited. It is t o be use d on ly f or t he p urpo se w hich it is lent and mus t no t be cop ied or u sed in a nyw ay d etrim enta l to the inte rest of this com pany and sub ject to retu rn o n de man dT his docu men t is exc lusi ve p rope rty of I OT DE SIG N & EN GIN EE RIN G L imite d. I t is to be u sed only for the pur pose whi ch it is le nt a nd m ust not be c opie d or use d in any way det rimen tal t o th e in tere st o f th is c ompa ny a nd s ubje ct t o re turn on dem and 1.650m 0.80 0m EL.100.450TOG 1.200mEL.100.300 0.150mEL.99.650 FGL0.200m 2.81 6m 0.995m Dia. 1.395m Dia. EL.96.834 0.300m Cross-Sectional Elevation 2.000m 2.00 0m (sq.



)1. 650m PLAN t Thi s do cum ent is e xclu sive pro pert y of IO T D ES IGN & E NG INE ER ING Lim ited. It is t o be use d on ly f or t he p urpo se w hich it is lent and mus t no t be cop ied or u sed in a nyw ay d etrim enta l to the inte rest of this com pany and sub ject to retu rn o n de man d 3.0 DESIGN OF FOUNDATION 3.1 Calculation of Vertical Dead LoadsPedestal Area, Ap 1.94 Volume, Vp 1.56Weight, Wp 3.89 T Shaft Area, As 0.75 Sectional modulus of shaft, Zs 0.17 Volume, Vs 2.11Weight, Ws 5.29 T Raft Area, Ar 4.00 Volume, Vr 1.20Weight, Wr 3.00 T Soil 12.53 T 3.2 Calculation of Seismic Forces CG of motor = 1012.50 mmmm CG of pump+barrel+sole plate = 2460.00 mmmm CG of Pump System w.r.t to bottom of base plate = -139.00 mm = Z I Sa/2 R g = 0.067 I = 1.75 As per table 6 of IS 1893-2002 Sa /g*Z/2 = 0.12 0 sec. time period considered as per Spec.SP001 Rev. A2, Pg.13 Cl.5.3.1 R = 3.0 (Table 16-O, UBC-1993) Horizontal seismic force = 0.44 TBending moment at shaft base = 1.52 T-mFactored Bending moment (Mu) = 2.28 T-m 3.3 Check for Base Pressure Static Load on soil 31.20 T Contact area 4.00Seismic moment 1.65 T-m Max. Pressure on soil 9.037 Min.
Pressure on soil 6.565Bearing Pressure is < gross bearing pressure of 9.9838 T/m2, Safe 3.4 Check for Buoyancy Uplift Total effective downward force 22.23 TUplift buoyant force on foundation 5.50 T Downward force is < buoyancy uplift force, Safe m2 m3 m2 m3 m3 m2 m3 Weight of soil, Wsoil CG considered at mid height of each component Design Horizontal seismic coeffiient Ah m2 T/m2 T/m2 T178 Manual Entries in calculation of distance of cg from ref point. Thi s do cum ent is e xclu sive pro pert y of IO T D ES IGN & E NG INE ER ING Lim ited. It is t o be use d on ly f or t he p urpo se w hich it is lent and mus t no t be cop ied or u sed in a nyw ay d etrim enta l to the inte rest of this com pany and sub ject to retu rn o n de man d 3.5 Design of the Circular Shaft Total weight coming on the shaft 15.68 TFactored load (Pu) 23.51 T =230669.2572 +22327851.1 750840.6442 169806028 Max. Min.0.439 0.176 Without considering the contribution of reinforcement in the axial compression, = 918.46 T Safe 3.6 Design of the R.C.C raftLength of cantilever = 1.43 m (Ref: Sketch-1)Bearing pressure per meter width = 9.04 T/mSoil pressure per meter width = 5.07 T/mEffective Uplift force = 3.97 T/mSagging moment at the face of the shaft = 4.08 T-mMu = 6.12 T-mEffective Depth, d = 242.00 mm = 1.10 Percentage reinf. Pt 0.319 % (Ref: Table - 4,Flexure, SP-16) = 957No. of bars = 5 Provide 16 dia. bar spaced at 200mm c/c2.000m Critical Length 2.000m1.3950m Sketch - 1 P/A + M/ZN/mm2 N/mm2 N/mm2 Permissible axial compression, Pc = 0.4*fck*Ac Mu/bd2 Ast required in per meter run mm2 PMC:INSTALLATION, OPERATION AND MAINTENANCE OF CRUDE AND FINISHED PRODUCTS TANKAGES FACILITY AT PARADIP REFINERY PROJECT, PARADIP ON BUILD-OWN-OPERATE-TRANSFER (BOOT) BASIS OWNER : Sheet 5 of 7 . TABLE 4, FLEXURE, SP-16, Rebar :- Dia, Area & Ut. Wt. Pt for Fe415D Area, Ut. Wt. 0.30 0.084 8 50.26548 3945840.35 0.098 10 78.53982 6165380.40 0.113 12 113.0973 8878140.45 0.127 16 201.0619 15783360.50 0.141 18 254.469 19975820.55 0.156 20 314.1593 24661500.60 0.170 22 380.1327 2984042 0.65 0.185 25 490.8739 38533600.70 0.2000.75 0.2140.80 0.2290.85 0.2440.90 0.2590.95 0.2741.00 0.2891.05 0.3041.10 0.3191.15 0.3341.20 0.351.25 0.3651.30 0.381.35 0.3951.40 0.4111.45 0.4271.50 0.4431.55 0.4591.60 0.4751.65 0.4911.70 0.5071.75 0.5231.80 0.5391.85 0.5561.90 0.5721.95 0.5892.00 0.6052.05 0.6222.10 0.6392.15 0.6562.20 0.6732.25 0.692.30 0.7072.35 0.7242.40 0.7422.45 0.7892.50 0.7772.55 0.7942.60 0.8122.65 0.832.70 0.8482.75 0.8662.80 0.8852.85 0.9032.90 0.9222.95 0.943.00 0.9593.05 0.9783.10 0.9973.15 1.0173.20 1.036 Mu/ bd2 PMC:INSTALLATION, OPERATION AND MAINTENANCE OF CRUDE AND FINISHED PRODUCTS TANKAGES FACILITY AT PARADIP REFINERY PROJECT, PARADIP ON BUILD-OWN-OPERATE-TRANSFER (BOOT) BASIS OWNER : Sheet 6 of 7 .
3.25 1.0553.30 1.0753.35 1.0953.40 1.1153.45 1.1353.50 1.1563.55 1.1763.60 1.1973.65 1.2183.70 1.2393.75 1.263.80 1.2813.85 1.3033.90 1.3253.95 1.3474.00 1.3694.05 1.3914.10 1.4144.154.204.254.304.354.404.45 PMC:INSTALLATION, OPERATION AND MAINTENANCE OF CRUDE AND FINISHED PRODUCTS TANKAGES FACILITY AT PARADIP REFINERY PROJECT, PARADIP ON BUILD-OWN-OPERATE-TRANSFER (BOOT) BASIS OWNER : Sheet 7 of 7 . K196 swm: provide spacing K200 swm: provide spacing "PUMPFDN" is a spreadsheet program written in MS-Excel for the purpose of analyzing "block-type" foundations for both small and large pump packages. Specifically, for small pump packages less than 5,000 lbs. in total weight, the foundation is analyzed in a simplistic manner involving only the mass ratio and the vertical mode natural frequency. For large pump packages equal to or greater than 5,000 lbs. in total weight, a simplified dynamic machine foundation damped vibration analysis is performed for the vertical, horizontal, and rocking modes for the purpose of evaluating foundation performance as related to peak-to-peak vibration amplitudes and peak vibration velocities. The soil bearing pressure is also checked, for both static and dynamic conditions. Small Pump - Simple Analysis for Foundations for Small Pumps Large Pump - Simplified Dynamic Machine Foundation Analysis for Large Pumps Program Assumptions and Limitations: 1. This program is based on the following references: a. "Design of Structures and Foundations for Vibrating Machines" by Suresh C. Arya, Michael W. O'Neill, and George Pincus - Gulf Publishing Company (5/1979) b. "Foundation Design for Vibrating Machines" by Suresh C. Arya, Roland P.Drewyer, and George Pincus - Hydrocarbon Processing (11/1975) c. "Foundation Design for Reciprocating Compressors" by Suresh C. Arya, Roland P.Drewyer, and George Pincus - Hydrocarbon Processing (5/1977) d.



Total Resistance (Pa)	51226.5
Design allowance (%)	15
Boosted Domestic Water Systems	Enter Below
Height To Furtherest Outlet (m)	10
Outlet Pressure (Bar)	1.5
Calculated Pump Duty	
Flow Rate 0.6	kg/s
Resistance 307.0	kPa

"Pump Foundation" - Structural Engineering Guideline 000.215.1227 by Fluor Enterprises (August 12, 2009) e. "Vibrating Machinery Foundations on Soil (Using Frequency Independent Criteria)" Structural Engineering Guideline 000.215.1233 - by Fluor Enterprises (April 13, 2009) f. "The Grouting Handbook - A Step-by-Step Guide to Heavy Equipment Grouting" by Don Harrison (Gulf Publishing Company, 2000) g. International Standards Organization ISO 1940-1 (8/2003) "Mechanical Vibration - Balance Quality Requirements for Rotors in a Constant (Rigid) State" Part 1: "Specification and Verification of Balance Tolerances" 2. For the purpose of this workbook, small pump packages are those with a total weight of less than 5,000 lbs., whereas large pump packages are those with a total weight equal to or greater than 5,000 lbs. 3. In the "Small Pump" worksheet, only the foundation minimum width, the mass (weight) ratio, the vertical mode natural frequency, and the static soil bearing pressure are checked. 4. In the "Large Pump" worksheet, initially the foundation minimum width and the the mass (weight) ratio are checked. Then a simplified dynamic machine foundation analysis for an assumed "block-type" foundation is performed. This includes frequency ratio checks, as well as a forced vibration analysis for only the vertical, horizontal, and rocking modes of vibration.
 (Note: torsional/twisting mode is not considered in this analysis.) Amplitudes and velocities of vibration are determined, and the machine foundation performance can then be manually evaluated by the user from the "General Machinery Vibration Severity Chart which is included. Finally, both the static and dynamic soil bearing pressures are checked. 5. In the "Large Pump" worksheet, the assumed dynamic analysis of a machine foundation supported on soil is made by the commonly accepted approach of idealizing the foundation-soil system as a simple lumped-parameter, mass-spring-dashpot vibrating system. The "block-type" foundation is assumed to be a rigid body vibrating on the surface of an elastic half-space. The equivalent soil spring represents the elastic resistance of the soil, while the dashpot represents the damping effect of the soil. 6. This program contains “comment boxes” which contain a wide variety of information including explanations of input or output items, equations used, data tables, etc. (Note: presence of a “comment box” is denoted by a “red triangle” in the upper right-hand corner of a cell. Merely move the mouse pointer to the desired cell to view the contents of that particular "comment box".) Calculation ReferenceMechanical Vibration Design of Structures and Foundations for Vibrating Machines Foundation Design for Reciprocating Compressors