Isolated Footing Design (IS 456-2000)

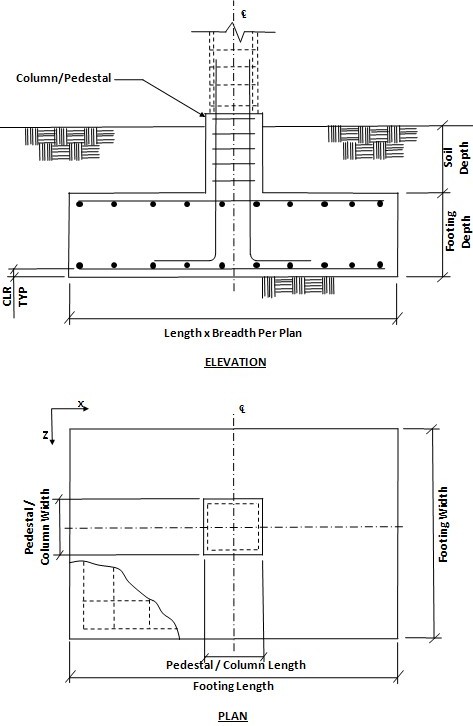
Design For Isolated Footing 32 Design For Isolated Footing 33 Design For Isolated Footing 34 Design For Isolated Footing 35 Design For Isolated Footing 36 Design For Isolated Footing 37 Design For Isolated Footing 38 Design For Isolated Footing 39 Design For Isolated Footing 40 Design For Isolated Footing 41 Design For Isolated Footing 42 Design For Isolated Footing 43 Design For Isolated Footing 44 Design For Isolated Footing 45 Design For Isolated Footing 46 Design For Isolated Footing 47 Design For Isolated Footing 173 Design For Isolated Footing 174

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Footing No. | Group ID | Foundation Geometry | | |
| - | - | Length | Width | Thickness |
| 32 | 1 | 3.500 m | 3.500 m | 0.406 m |
| 33 | 2 | 1.900 m | 1.900 m | 0.305 m |
| 34 | 3 | 1.900 m | 1.900 m | 0.305 m |
| 35 | 4 | 3.500 m | 3.500 m | 0.406 m |
| 36 | 5 | 1.950 m | 1.950 m | 0.305 m |
| 37 | 6 | 2.350 m | 2.350 m | 0.305 m |
| 38 | 7 | 2.350 m | 2.350 m | 0.305 m |
| 39 | 8 | 1.800 m | 1.800 m | 0.305 m |
| 40 | 9 | 1.950 m | 1.950 m | 0.305 m |
| 41 | 10 | 2.350 m | 2.350 m | 0.305 m |
| 42 | 11 | 2.350 m | 2.350 m | 0.305 m |
| 43 | 12 | 1.800 m | 1.800 m | 0.305 m |
| 44 | 13 | 3.500 m | 3.500 m | 0.406 m |
| 45 | 14 | 1.900 m | 1.900 m | 0.305 m |
| 46 | 15 | 1.900 m | 1.900 m | 0.305 m |
| 47 | 16 | 3.500 m | 3.500 m | 0.406 m |
| 173 | 17 | 1.300 m | 1.300 m | 0.305 m |
| 174 | 18 | 1.300 m | 1.300 m | 0.305 m |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Footing No. | Footing Reinforcement | | | | Pedestal Reinforcement | |
| - | Bottom Reinforcement(Mz) | Bottom Reinforcement(Mx) | Top Reinforcement(Mz) | Top Reinforcement(Mx) | Main Steel | Trans Steel |
| 32 | Ø8 @ 50 mm c/c | Ø8 @ 55 mm c/c | Ø6 @ 75 mm c/c | Ø6 @ 75 mm c/c | N/A | N/A |
|  |  |  |  |  |  |  |

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| 33 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 34 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 35 | Ø8 @ 50 mm c/c | Ø8 @ 55 mm c/c | Ø6 @ 75 mm c/c | Ø6 @ 75 mm c/c | N/A | N/A |
| 36 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 37 | Ø6 @ 50 mm c/c | Ø6 @ 60 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 38 | Ø6 @ 50 mm c/c | Ø6 @ 60 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 39 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 40 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 41 | Ø6 @ 50 mm c/c | Ø6 @ 60 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 42 | Ø6 @ 50 mm c/c | Ø6 @ 60 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 43 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 44 | Ø8 @ 50 mm c/c | Ø8 @ 55 mm c/c | Ø6 @ 75 mm c/c | Ø6 @ 75 mm c/c | N/A | N/A |
| 45 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 46 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 47 | Ø8 @ 50 mm c/c | Ø8 @ 55 mm c/c | Ø6 @ 75 mm c/c | Ø6 @ 75 mm c/c | N/A | N/A |
| 173 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |
| 174 | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | Ø6 @ 70 mm c/c | N/A | N/A |

# Isolated Footing 32



## Input Values

### Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1124.187 | -1.923 | -0.953 | -0.914 | 1.963 |
| 2 | 141.831 | -5.712 | -3.134 | -3.022 | 5.874 |
| 4 | 35.458 | -1.428 | -0.784 | -0.756 | 1.468 |
| 5 | 0.011 | -0.021 | 0.019 | 0.016 | 0.028 |
| 6 | 0.016 | -0.001 | -0.025 | -0.022 | 0.015 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1124.187 | -1.923 | -0.953 | -0.914 | 1.963 |
| 2 | 141.831 | -5.712 | -3.134 | -3.022 | 5.874 |
| 4 | 35.458 | -1.428 | -0.784 | -0.756 | 1.468 |
| 5 | 0.011 | -0.021 | 0.019 | 0.016 | 0.028 |
| 6 | 0.016 | -0.001 | -0.025 | -0.022 | 0.015 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2

Min. area required from bearing pressure, Amin = P / qmax = 11.318 m2

**Note: Amin is an initial estimation.**

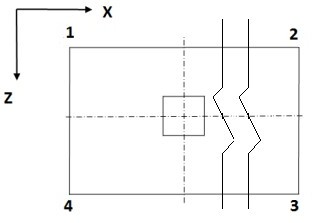
**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

Final Footing Size

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Length (L2) = | 3.500 | m | Governing Load Case : | # 1 |
| Width (W2) = | 3.500 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.406 | m | Governing Load Case : | # 1 |

Area (A2) = 12.250 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **99.9207** | 99.2072 | 98.8701 | 99.5836 | 0.000 |
| 1 | 99.9207 | **99.2072** | 98.8701 | 99.5836 | 0.000 |
| 1 | 99.9207 | 99.2072 | **98.8701** | 99.5836 | 0.000 |
| 1 | 99.9207 | 99.2072 | 98.8701 | **99.5836** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)** | **Pressure at corner 2 (q2)** | **Pressure at corner 3 (q3)** | **Pressure at corner 4 (q4)** |

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | **(kN/m2)** | **(kN/m2)** | **(kN/m2)** | **(kN/m2)** |
| 1 | **99.9207** | 99.2072 | 98.8701 | 99.5836 |
| 1 | 99.9207 | **99.2072** | 98.8701 | 99.5836 |
| 1 | 99.9207 | 99.2072 | **98.8701** | 99.5836 |
| 1 | 99.9207 | 99.2072 | 98.8701 | **99.5836** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 316.553 | 639.096 | 1769.158 | 835.861 |
| 2 | 20.591 | 37.526 | 103.483 | 54.054 |
| 4 | 45.120 | 82.227 | 226.754 | 118.444 |
| 5 | 2272.599 | 2417.636 | 7333.729 | 4779.761 |
| 6 | 43250.878 | 1904.937 | 5609.499 | 10818.874 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -5.712 kN

Governing Restoring Force : 117.619 kN Minimum Sliding Ratio for the Critical Load Case : 20.591

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -3.978 kNm Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 103.483

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -3.134 kN

Governing Restoring Force : 117.619 kN Minimum Sliding Ratio for the Critical Load Case : 37.526

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 7.616 kNm Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 54.054

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 373.971 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 399.460 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

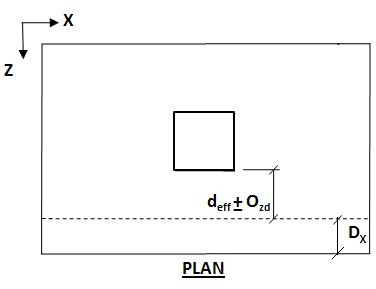
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

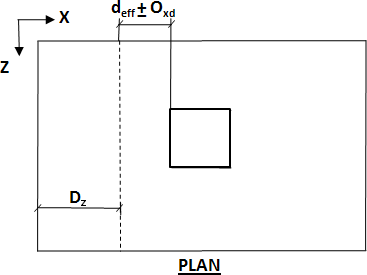
DX = 0.352 m

Shear Force(S) = 377.223 kN

Shear Stress(Tv) = 306.187772 kN/m2 Percentage Of Steel(Pt) = 0.2670

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 375.288 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

DZ = 0.352 m

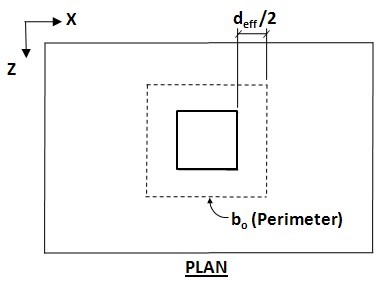
Shear Force(S) = 393.817 kN

Shear Stress(Tv) = 319.656277 kN/m2 Percentage Of Steel(Pt) = 0.2492

As Per IS 456 2000 Clause 40 Table 19

Shear Strength Of Concrete(Tc) = 364.214 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 1072.520 kN Shear Stress(Tv) = 1012.943 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.525 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.475 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3069.587 mm2 Provided Area of Steel (Ast,Provided) = 3069.587 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = 48.000 mm

Selected spacing (S) = 55.607 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 55.000 mm o.c.**

Along X Axis

For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3288.947 mm2 Provided Area of Steel (Ast,Provided) = 3288.947 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 52.185 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 34.480 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 75.422 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 36.778 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 75.422 mm

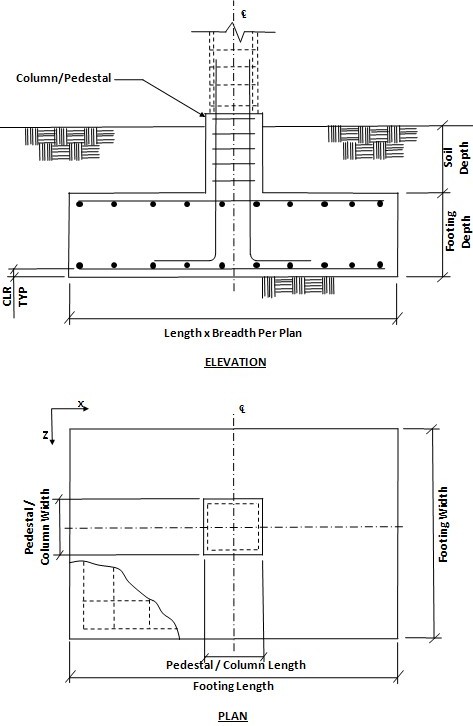
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

**Isolated Footing 33**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.114 | 0.550 | -1.551 | -1.528 | -0.473 |
| 2 | 290.751 | 0.032 | -6.770 | -6.676 | 0.226 |
| 4 | 72.688 | 0.008 | -1.692 | -1.669 | 0.056 |
| 5 | 0.005 | -0.011 | 0.000 | 0.000 | 0.019 |
| 6 | -0.020 | -0.008 | -0.077 | -0.067 | 0.021 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.114 | 0.550 | -1.551 | -1.528 | -0.473 |
| 2 | 290.751 | 0.032 | -6.770 | -6.676 | 0.226 |
| 4 | 72.688 | 0.008 | -1.692 | -1.669 | 0.056 |
| 5 | 0.005 | -0.011 | 0.000 | 0.000 | 0.019 |
| 6 | -0.020 | -0.008 | -0.077 | -0.067 | 0.021 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.984 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

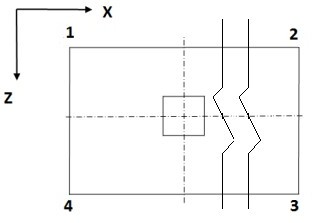
Final Footing Size

Length (L2) = 1.900 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.900 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.610 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **96.0005** | 95.6224 | 80.3304 | 80.7086 | 0.000 |
| 2 | 96.0005 | **95.6224** | 80.3304 | 80.7086 | 0.000 |
| 2 | 96.0005 | 95.6224 | **80.3304** | 80.7086 | 0.000 |
| 2 | 96.0005 | 95.6224 | 80.3304 | **80.7086** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **96.0005** | 95.6224 | 80.3304 | 80.7086 |
| 2 | 96.0005 | **95.6224** | 80.3304 | 80.7086 |
| 2 | 96.0005 | 95.6224 | **80.3304** | 80.7086 |
| 2 | 96.0005 | 95.6224 | 80.3304 | **80.7086** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 185.211 | 65.647 | 96.663 | 302.094 |
| 2 | 5040.980 | 23.508 | 34.593 | 1398.837 |
| 4 | 6349.090 | 29.607 | 43.568 | 1761.787 |
| 5 | 1248.120 | 60641.051 | 86824.191 | 1152.950 |
| 6 | 1628.733 | 178.247 | 287.499 | 1094.508 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 1

Governing Disturbing Force : 0.550 kN

Governing Restoring Force : 101.820 kN Minimum Sliding Ratio for the Critical Load Case : 185.211

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -8.740 kNm Governing Resisting Moment : 302.358 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.593

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -6.770 kN

Governing Restoring Force : 159.139 kN Minimum Sliding Ratio for the Critical Load Case : 23.508

Critical Load Case for Overturning about Z-Direction : 1

Governing Overturning Moment : -0.640 kNm Governing Resisting Moment : 193.455 kNm

Minimum Overturning Ratio for the Critical Load Case : 302.094

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 43.063 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

Check Trial inst moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 46.034 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

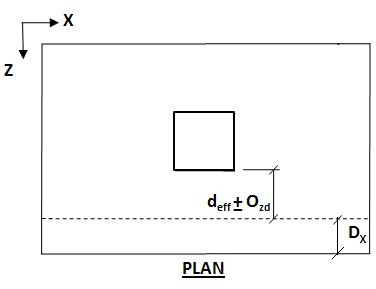
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

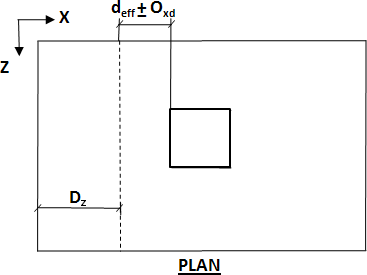
Shear Force(S) = 77.543 kN

Shear Stress(Tv) = 161.951830 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

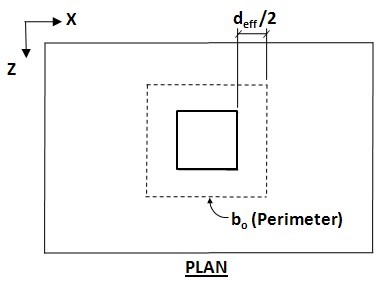
DZ = 0.252 m

Shear Force(S) = 80.169 kN

Shear Stress(Tv) = 167.437865 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 256.714 kN Shear Stress(Tv) = 390.609 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.725 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 481.336 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 515.159 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.230 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.834 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

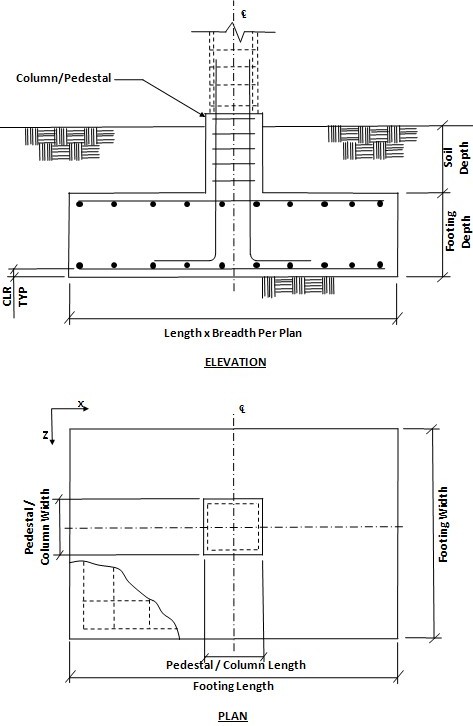
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 34**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.174 | -0.668 | -1.551 | -1.528 | 0.729 |
| 2 | 290.811 | -0.461 | -6.770 | -6.676 | 0.699 |
| 4 | 72.703 | -0.115 | -1.693 | -1.669 | 0.175 |
| 5 | 0.004 | -0.003 | 0.000 | 0.000 | 0.013 |
| 6 | -0.021 | -0.014 | -0.077 | -0.067 | 0.026 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.174 | -0.668 | -1.551 | -1.528 | 0.729 |
| 2 | 290.811 | -0.461 | -6.770 | -6.676 | 0.699 |
| 4 | 72.703 | -0.115 | -1.693 | -1.669 | 0.175 |
| 5 | 0.004 | -0.003 | 0.000 | 0.000 | 0.013 |
| 6 | -0.021 | -0.014 | -0.077 | -0.067 | 0.026 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.984 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

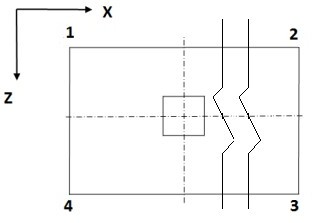
Final Footing Size

Length (L2) = 1.900 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.900 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.610 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **96.5633** | 95.0945 | 79.8008 | 81.2696 | 0.000 |
| 2 | 96.5633 | **95.0945** | 79.8008 | 81.2696 | 0.000 |
| 2 | 96.5633 | 95.0945 | **79.8008** | 81.2696 | 0.000 |
| 2 | 96.5633 | 95.0945 | 79.8008 | **81.2696** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **96.5633** | 95.0945 | 79.8008 | 81.2696 |
| 2 | 96.5633 | **95.0945** | 79.8008 | 81.2696 |
| 2 | 96.5633 | 95.0945 | **79.8008** | 81.2696 |
| 2 | 96.5633 | 95.0945 | 79.8008 | **81.2696** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 152.361 | 65.688 | 96.726 | 207.481 |
| 2 | 345.205 | 23.509 | 34.596 | 360.226 |
| 4 | 434.754 | 29.608 | 43.570 | 453.670 |
| 5 | 4045.039 | 72448.775 | 109913.878 | 1888.797 |
| 6 | 966.397 | 178.314 | 288.935 | 858.576 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 1

Governing Disturbing Force : -0.668 kN

Governing Restoring Force : 101.850 kN Minimum Sliding Ratio for the Critical Load Case : 152.361

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -8.741 kNm Governing Resisting Moment : 302.415 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.596

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -6.770 kN

Governing Restoring Force : 159.169 kN Minimum Sliding Ratio for the Critical Load Case : 23.509

Critical Load Case for Overturning about Z-Direction : 1

Governing Overturning Moment : 0.933 kNm Governing Resisting Moment : 193.512 kNm

Minimum Overturning Ratio for the Critical Load Case : 207.481

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 43.071 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 46.270 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

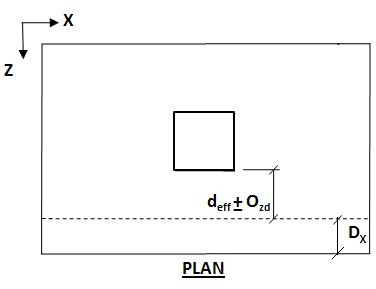
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

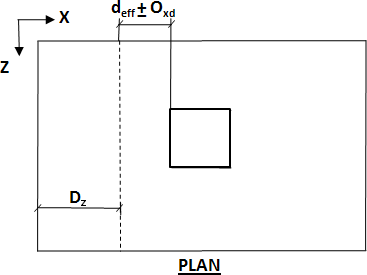
Shear Force(S) = 77.558 kN

Shear Stress(Tv) = 161.984191 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

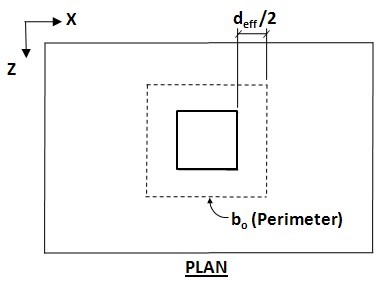
DZ = 0.252 m

Shear Force(S) = 80.578 kN

Shear Stress(Tv) = 168.292492 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 256.767 kN Shear Stress(Tv) = 390.689 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.725 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 481.434 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 517.849 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.230 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.834 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

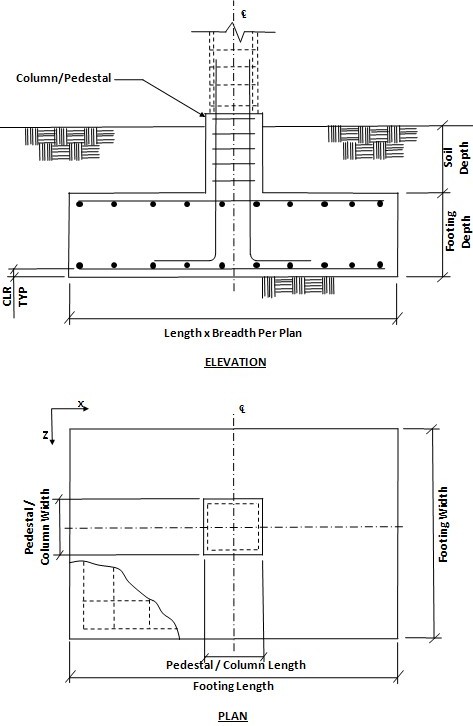
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 35**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1123.359 | 1.823 | -0.899 | -0.861 | -1.725 |
| 2 | 140.963 | 5.327 | -3.098 | -2.984 | -4.993 |
| 4 | 35.241 | 1.332 | -0.774 | -0.746 | -1.248 |
| 5 | -0.011 | 0.006 | 0.021 | 0.018 | 0.004 |
| 6 | -0.017 | -0.022 | -0.022 | -0.019 | 0.033 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1123.359 | 1.823 | -0.899 | -0.861 | -1.725 |
| 2 | 140.963 | 5.327 | -3.098 | -2.984 | -4.993 |
| 4 | 35.241 | 1.332 | -0.774 | -0.746 | -1.248 |
| 5 | -0.011 | 0.006 | 0.021 | 0.018 | 0.004 |
| 6 | -0.017 | -0.022 | -0.022 | -0.019 | 0.033 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 11.310 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

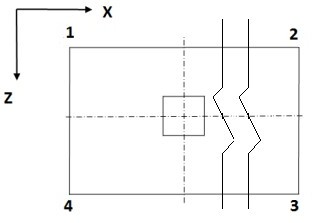
Final Footing Size

Length (L2) = 3.500 m Governing Load Case : # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 3.500 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.406 | m | Governing Load Case : | # 1 |

Area (A2) = 12.250 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **99.1674** | 99.8058 | 99.4881 | 98.8498 | 0.000 |
| 1 | 99.1674 | **99.8058** | 99.4881 | 98.8498 | 0.000 |
| 1 | 99.1674 | 99.8058 | **99.4881** | 98.8498 | 0.000 |
| 1 | 99.1674 | 99.8058 | 99.4881 | **98.8498** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 1 | **99.1674** | 99.8058 | 99.4881 | 98.8498 |
| 1 | 99.1674 | **99.8058** | 99.4881 | 98.8498 |
| 1 | 99.1674 | 99.8058 | **99.4881** | 98.8498 |
| 1 | 99.1674 | 99.8058 | 99.4881 | **98.8498** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 333.745 | 676.534 | 1876.224 | 933.629 |
| 2 | 21.998 | 37.831 | 104.388 | 61.977 |
| 4 | 48.299 | 83.063 | 229.196 | 136.078 |
| 5 | 7866.826 | 2207.605 | 6615.266 | 64031.297 |
| 6 | 2137.349 | 2150.242 | 6400.943 | 4125.248 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : 5.327 kN

Governing Restoring Force : 117.185 kN Minimum Sliding Ratio for the Critical Load Case : 21.998

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -3.929 kNm Governing Resisting Moment : 410.139 kNm

Minimum Overturning Ratio for the Critical Load Case : 104.388

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -3.098 kN

Governing Restoring Force : 117.185 kN Minimum Sliding Ratio for the Critical Load Case : 37.831

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : -6.618 kNm Governing Resisting Moment : 410.139 kNm

Minimum Overturning Ratio for the Critical Load Case : 61.977

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 373.668 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 399.053 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

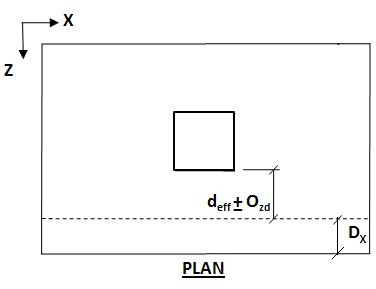
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

DX = 0.352 m

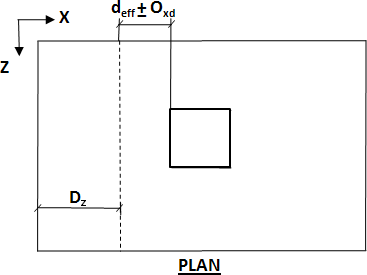
Shear Force(S) = 376.919 kN

Shear Stress(Tv) = 305.940913 kN/m2

Percentage Of Steel(Pt) = 0.2667

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 375.114 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

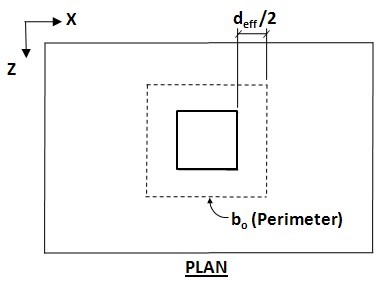
DZ = 0.352 m

Shear Force(S) = 393.422 kN

Shear Stress(Tv) = 319.336431 kN/m2 Percentage Of Steel(Pt) = 0.2489

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 364.079 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 1071.730 kN Shear Stress(Tv) = 1012.196 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.525 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.475 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3066.986 mm2 Provided Area of Steel (Ast,Provided) = 3066.986 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = 48.000 mm

Selected spacing (S) = 55.607 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 55.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3285.435 mm2 Provided Area of Steel (Ast,Provided) = 3285.435 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 52.185 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 34.480 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 75.422 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 36.778 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 75.422 mm

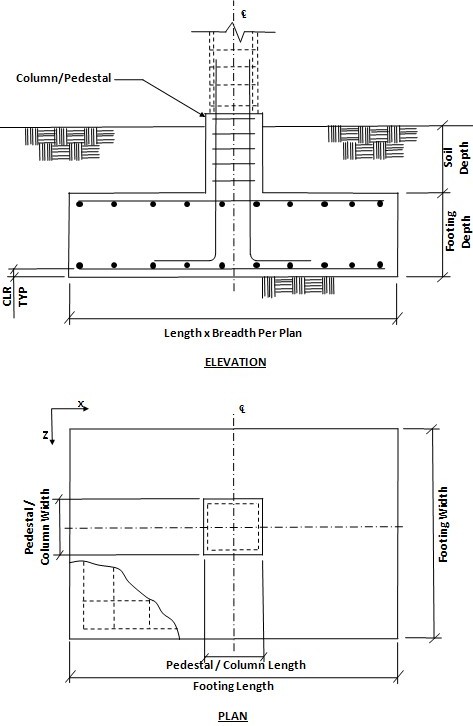
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

**Isolated Footing 36**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 227.514 | -1.576 | 1.163 | 1.134 | 1.671 |
| 2 | 309.201 | -7.012 | 0.302 | 0.297 | 7.345 |
| 4 | 77.300 | -1.753 | 0.076 | 0.074 | 1.836 |
| 5 | 0.071 | -0.021 | 0.002 | 0.001 | 0.016 |
| 6 | 0.022 | 0.010 | -0.009 | -0.008 | -0.020 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 227.514 | -1.576 | 1.163 | 1.134 | 1.671 |
| 2 | 309.201 | -7.012 | 0.302 | 0.297 | 7.345 |
| 4 | 77.300 | -1.753 | 0.076 | 0.074 | 1.836 |
| 5 | 0.071 | -0.021 | 0.002 | 0.001 | 0.016 |
| 6 | 0.022 | 0.010 | -0.009 | -0.008 | -0.020 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 3.168 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

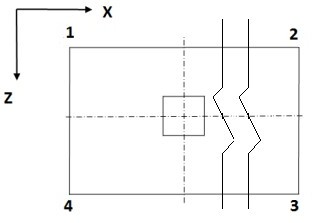
Final Footing Size

Length (L2) = 1.950 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.950 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.803 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **96.2986** | 80.9512 | 81.5819 | 96.9293 | 0.000 |
| 2 | 96.2986 | **80.9512** | 81.5819 | 96.9293 | 0.000 |
| 2 | 96.2986 | 80.9512 | **81.5819** | 96.9293 | 0.000 |
| 2 | 96.2986 | 80.9512 | 81.5819 | **96.9293** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **96.2986** | 80.9512 | 81.5819 | 96.9293 |
| 2 | 96.2986 | **80.9512** | 81.5819 | 96.9293 |
| 2 | 96.2986 | 80.9512 | **81.5819** | 96.9293 |
| 2 | 96.2986 | 80.9512 | 81.5819 | **96.9293** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.803 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 81.356 | 110.319 | 167.995 | 116.208 |
| 2 | 24.116 | 559.135 | 846.150 | 34.771 |
| 4 | 30.319 | 702.940 | 1063.771 | 43.714 |
| 5 | 681.230 | 7889.618 | 20948.042 | 1249.912 |
| 6 | 1463.993 | 1664.736 | 2699.240 | 1245.170 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -7.012 kN

Governing Restoring Force : 169.098 kN Minimum Sliding Ratio for the Critical Load Case : 24.116

Critical Load Case for Overturning about X-Direction : 1

Governing Overturning Moment : 1.489 kNm Governing Resisting Moment : 250.091 kNm

Minimum Overturning Ratio for the Critical Load Case : 167.995

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 1

Governing Disturbing Force : 1.163 kN

Governing Restoring Force : 128.254 kN Minimum Sliding Ratio for the Critical Load Case : 110.319

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 9.483 kNm Governing Resisting Moment : 329.734 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.771

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 44.724 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 426.508437 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 54.217 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

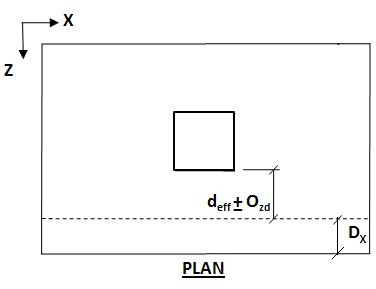
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 426.508437 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

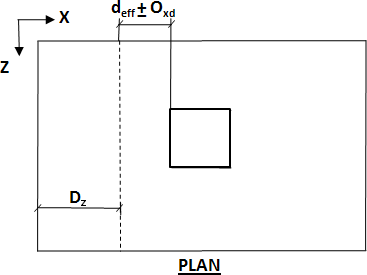
Shear Force(S) = 79.193 kN

Shear Stress(Tv) = 161.158437 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

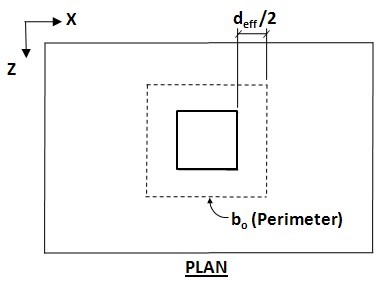
DZ = 0.252 m

Shear Force(S) = 92.789 kN

Shear Stress(Tv) = 188.826070 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 274.837 kN Shear Stress(Tv) = 418.184 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.750 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.700 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 500.013 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 608.412 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 713.700 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.646 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 713.700 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 5.287 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.760 mm

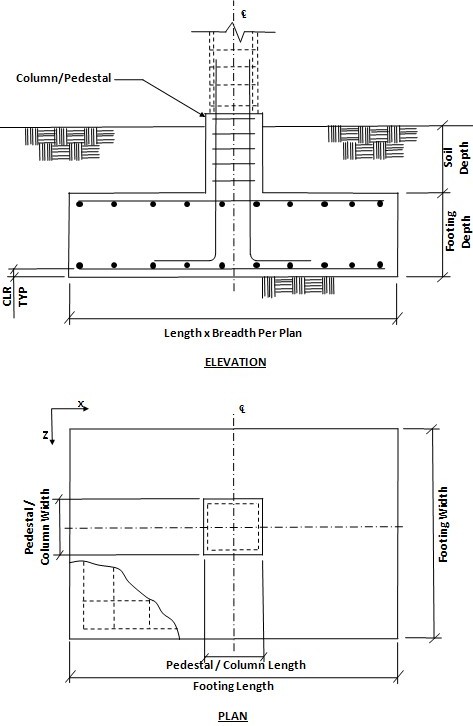
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 37**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.815 | 0.014 | 0.813 | 0.786 | 0.089 |
| 2 | 483.319 | -0.017 | 3.554 | 3.431 | 0.399 |
| 4 | 120.830 | -0.004 | 0.889 | 0.858 | 0.100 |
| 5 | 0.019 | -0.002 | 0.000 | 0.000 | 0.002 |
| 6 | 0.015 | 0.008 | -0.019 | -0.016 | -0.018 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.815 | 0.014 | 0.813 | 0.786 | 0.089 |
| 2 | 483.319 | -0.017 | 3.554 | 3.431 | 0.399 |
| 4 | 120.830 | -0.004 | 0.889 | 0.858 | 0.100 |
| 5 | 0.019 | -0.002 | 0.000 | 0.000 | 0.002 |
| 6 | 0.015 | 0.008 | -0.019 | -0.016 | -0.018 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 4.909 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

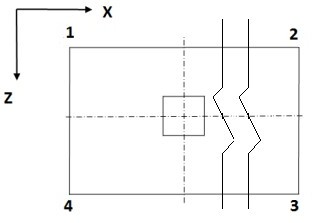
Final Footing Size

Length (L2) = 2.350 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 2.350 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 5.523 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **93.2426** | 92.8689 | 97.0436 | 97.4173 | 0.000 |
| 2 | 93.2426 | **92.8689** | 97.0436 | 97.4173 | 0.000 |
| 2 | 93.2426 | 92.8689 | **97.0436** | 97.4173 | 0.000 |
| 2 | 93.2426 | 92.8689 | 97.0436 | **97.4173** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **93.2426** | 92.8689 | 97.0436 | 97.4173 |
| 2 | 93.2426 | **92.8689** | 97.0436 | 97.4173 |
| 2 | 93.2426 | 92.8689 | **97.0436** | 97.4173 |
| 2 | 93.2426 | 92.8689 | 97.0436 | **97.4173** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 8202.213 | 141.322 | 261.332 | 3195.090 |
| 2 | 15705.035 | 73.912 | 136.742 | 1527.686 |
| 4 | 19480.956 | 91.682 | 169.619 | 1894.983 |
| 5 | 11367.505 | 319151.324 | 581467.991 | 23934.439 |
| 6 | 2574.840 | 1127.828 | 2306.021 | 2390.668 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 6

Governing Disturbing Force : 0.008 kN

Governing Restoring Force : 21.062 kN Minimum Sliding Ratio for the Critical Load Case : 2574.840

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 4.515 kNm Governing Resisting Moment : 617.366 kNm

Minimum Overturning Ratio for the Critical Load Case : 136.742

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 3.554 kN

Governing Restoring Force : 262.714 kN Minimum Sliding Ratio for the Critical Load Case : 73.912

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 0.404 kNm Governing Resisting Moment : 617.366 kNm

Minimum Overturning Ratio for the Critical Load Case : 1527.686

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 94.424 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 102.989 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

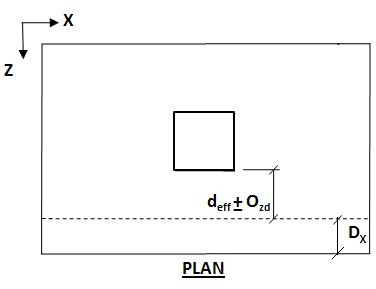
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

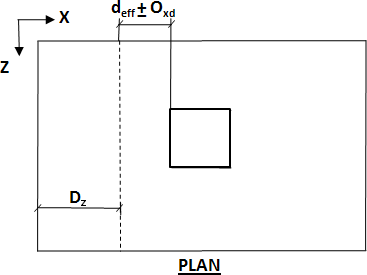
Shear Force(S) = 145.963 kN

Shear Stress(Tv) = 246.475560 kN/m2

Percentage Of Steel(Pt) = 0.1976

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 329.021 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

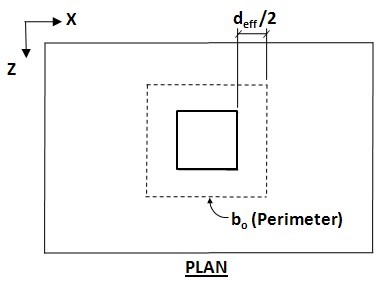
DZ = 0.252 m

Shear Force(S) = 154.063 kN

Shear Stress(Tv) = 260.153953 kN/m2 Percentage Of Steel(Pt) = 0.1807

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 316.189 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 446.333 kN Shear Stress(Tv) = 679.127 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.950 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.900 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1069.911 mm2

Provided Area of Steel (Ast,Provided) = 1069.911 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 60.649 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 60.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1170.355 mm2

Provided Area of Steel (Ast,Provided) = 1170.355 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 54.732 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 8.984 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.800 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 9.955 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.800 mm

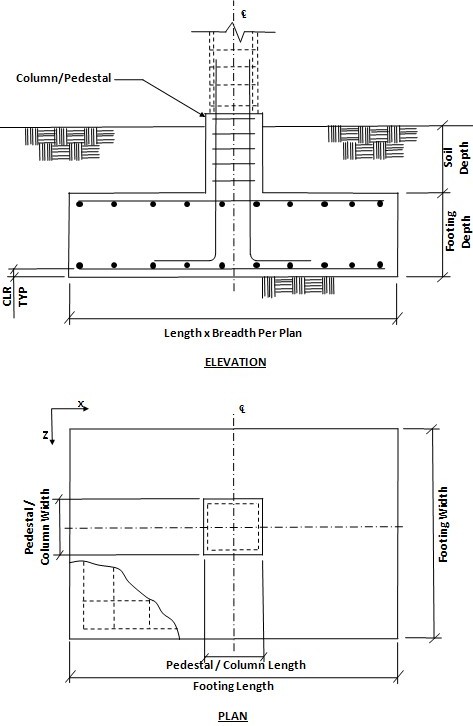
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 38**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.882 | -0.167 | 0.815 | 0.787 | 0.246 |
| 2 | 484.951 | -0.610 | 3.572 | 3.448 | 0.901 |
| 4 | 121.238 | -0.153 | 0.893 | 0.862 | 0.225 |
| 5 | 0.018 | 0.023 | 0.000 | 0.000 | -0.018 |
| 6 | 0.015 | 0.008 | -0.019 | -0.016 | -0.019 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.882 | -0.167 | 0.815 | 0.787 | 0.246 |
| 2 | 484.951 | -0.610 | 3.572 | 3.448 | 0.901 |
| 4 | 121.238 | -0.153 | 0.893 | 0.862 | 0.225 |
| 5 | 0.018 | 0.023 | 0.000 | 0.000 | -0.018 |
| 6 | 0.015 | 0.008 | -0.019 | -0.016 | -0.019 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 4.926 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

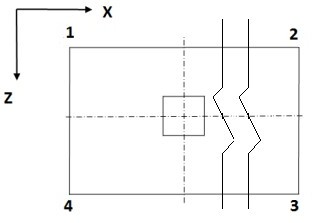
Final Footing Size

Length (L2) = 2.350 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 2.350 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 5.523 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **93.8436** | 92.8386 | 97.0338 | 98.0388 | 0.000 |
| 2 | 93.8436 | **92.8386** | 97.0338 | 98.0388 | 0.000 |
| 2 | 93.8436 | 92.8386 | **97.0338** | 98.0388 | 0.000 |
| 2 | 93.8436 | 92.8386 | 97.0338 | **98.0388** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **93.8436** | 92.8386 | 97.0338 | 98.0388 |
| 2 | 93.8436 | **92.8386** | 97.0338 | 98.0388 |
| 2 | 93.8436 | 92.8386 | **97.0338** | 98.0388 |
| 2 | 93.8436 | 92.8386 | 97.0338 | **98.0388** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 687.193 | 141.083 | 260.879 | 909.332 |
| 2 | 432.004 | 73.782 | 136.497 | 569.792 |
| 4 | 535.549 | 91.467 | 169.212 | 706.362 |
| 5 | 916.130 | 421273.299 | 808156.949 | 1952.681 |
| 6 | 2503.239 | 1131.041 | 2325.220 | 2336.354 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -0.610 kN

Governing Restoring Force : 263.530 kN Minimum Sliding Ratio for the Critical Load Case : 432.004

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 4.537 kNm Governing Resisting Moment : 619.284 kNm

Minimum Overturning Ratio for the Critical Load Case : 136.497

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 3.572 kN

Governing Restoring Force : 263.530 kN Minimum Sliding Ratio for the Critical Load Case : 73.782

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 1.087 kNm Governing Resisting Moment : 619.284 kNm

Minimum Overturning Ratio for the Critical Load Case : 569.792

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 94.746 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 103.602 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

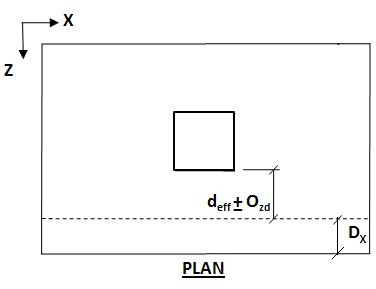
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

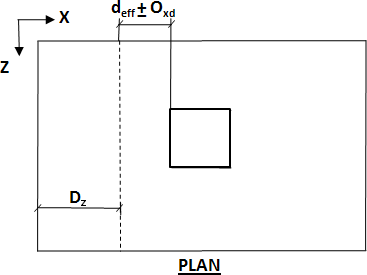
Shear Force(S) = 146.460 kN

Shear Stress(Tv) = 247.314299 kN/m2

Percentage Of Steel(Pt) = 0.1988

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 329.915 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

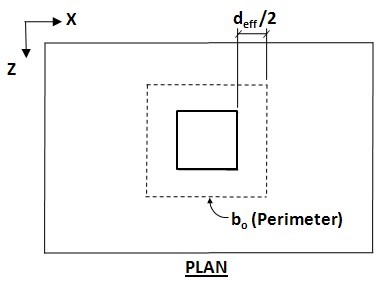
DZ = 0.252 m

Shear Force(S) = 154.961 kN

Shear Stress(Tv) = 261.670094 kN/m2 Percentage Of Steel(Pt) = 0.1813

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 316.683 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 447.841 kN Shear Stress(Tv) = 681.421 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.950 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.900 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1073.669 mm2

Provided Area of Steel (Ast,Provided) = 1073.669 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 60.649 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 60.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1177.566 mm2

Provided Area of Steel (Ast,Provided) = 1177.566 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 54.732 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 8.984 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.800 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 9.955 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.800 mm

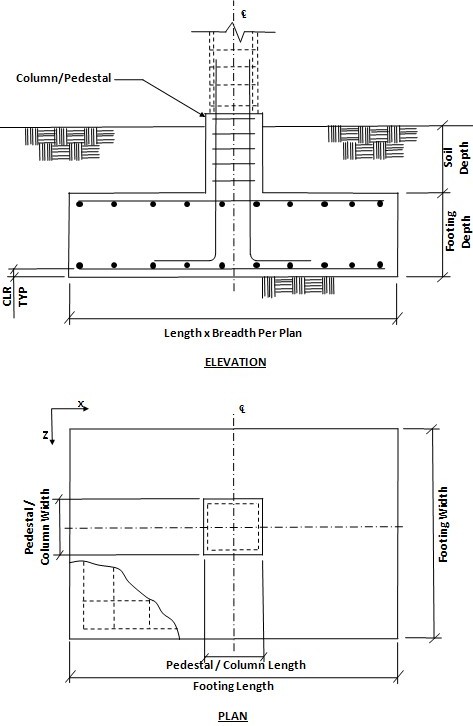
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 39**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 149.351 | 2.503 | 1.330 | 1.301 | -2.398 |
| 2 | 234.210 | 9.466 | 1.851 | 1.806 | -9.076 |
| 4 | 58.553 | 2.367 | 0.463 | 0.451 | -2.269 |
| 5 | -0.029 | 0.059 | 0.004 | 0.004 | -0.051 |
| 6 | 0.016 | 0.006 | -0.006 | -0.005 | -0.016 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 149.351 | 2.503 | 1.330 | 1.301 | -2.398 |
| 2 | 234.210 | 9.466 | 1.851 | 1.806 | -9.076 |
| 4 | 58.553 | 2.367 | 0.463 | 0.451 | -2.269 |
| 5 | -0.029 | 0.059 | 0.004 | 0.004 | -0.051 |
| 6 | 0.016 | 0.006 | -0.006 | -0.005 | -0.016 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.418 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

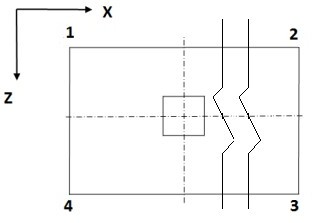
Final Footing Size

Length (L2) = 1.800 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.800 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.240 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **65.1656** | 89.7815 | 94.6587 | 70.0428 | 0.000 |
| 2 | 65.1656 | **89.7815** | 94.6587 | 70.0428 | 0.000 |
| 2 | 65.1656 | 89.7815 | **94.6587** | 70.0428 | 0.000 |
| 2 | 65.1656 | 89.7815 | 94.6587 | **70.0428** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **65.1656** | 89.7815 | 94.6587 | 70.0428 |
| 2 | 65.1656 | **89.7815** | 94.6587 | 70.0428 |
| 2 | 65.1656 | 89.7815 | **94.6587** | 70.0428 |
| 2 | 65.1656 | 89.7815 | 94.6587 | **70.0428** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.240 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 34.763 | 65.434 | 91.791 | 49.548 |
| 2 | 13.676 | 69.928 | 98.309 | 19.478 |
| 4 | 17.590 | 89.945 | 126.450 | 25.054 |
| 5 | 208.720 | 2860.626 | 4594.672 | 321.969 |
| 6 | 2055.291 | 2007.230 | 3037.734 | 1217.701 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : 9.466 kN

Governing Restoring Force : 129.458 kN Minimum Sliding Ratio for the Critical Load Case : 13.676

Critical Load Case for Overturning about X-Direction : 1

Governing Overturning Moment : 1.707 kNm Governing Resisting Moment : 156.647 kNm

Minimum Overturning Ratio for the Critical Load Case : 91.791

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 1

Governing Disturbing Force : 1.330 kN

Governing Restoring Force : 87.028 kN Minimum Sliding Ratio for the Critical Load Case : 65.434

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : -11.963 kNm Governing Resisting Moment : 233.020 kNm

Minimum Overturning Ratio for the Critical Load Case : 19.478

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 30.393 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 393.700096 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 38.459 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

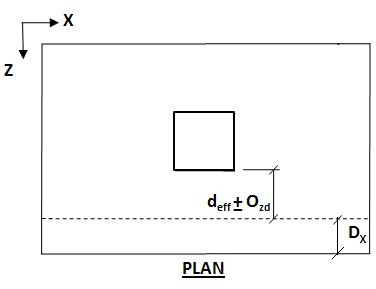
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 393.700096 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

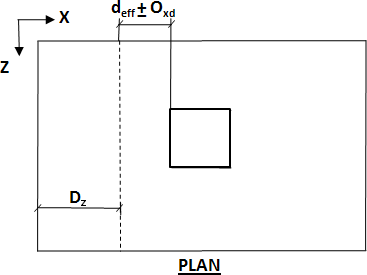
Shear Force(S) = 56.460 kN

Shear Stress(Tv) = 124.470588 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

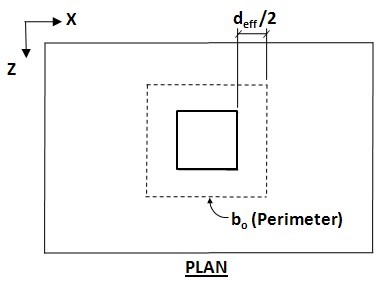
DZ = 0.252 m

Shear Force(S) = 69.271 kN

Shear Stress(Tv) = 152.713029 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 203.662 kN Shear Stress(Tv) = 309.885 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.484 m

Allowable Length(ldb) = = 0.625 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 338.234 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 429.452 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 658.800 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 3.474 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 658.800 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.008 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.652 mm

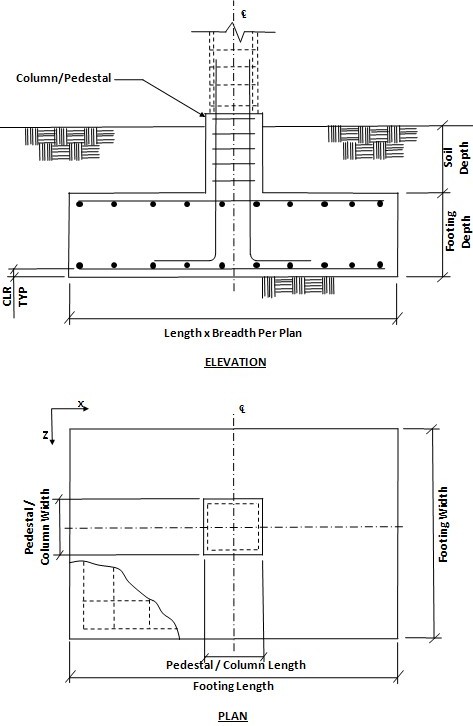
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 40**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 227.514 | -1.576 | -1.163 | -1.134 | 1.671 |
| 2 | 309.201 | -7.012 | -0.302 | -0.297 | 7.345 |
| 4 | 77.300 | -1.753 | -0.076 | -0.074 | 1.836 |
| 5 | 0.071 | -0.021 | -0.002 | -0.001 | 0.016 |
| 6 | 0.022 | 0.010 | 0.009 | 0.008 | -0.020 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 227.514 | -1.576 | -1.163 | -1.134 | 1.671 |
| 2 | 309.201 | -7.012 | -0.302 | -0.297 | 7.345 |
| 4 | 77.300 | -1.753 | -0.076 | -0.074 | 1.836 |
| 5 | 0.071 | -0.021 | -0.002 | -0.001 | 0.016 |
| 6 | 0.022 | 0.010 | 0.009 | 0.008 | -0.020 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 3.168 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

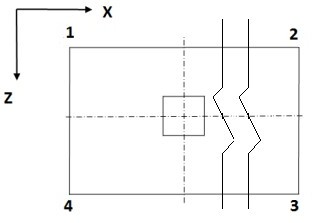
Final Footing Size

Length (L2) = 1.950 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.950 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.803 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **96.9292** | 81.5819 | 80.9512 | 96.2986 | 0.000 |
| 2 | 96.9292 | **81.5819** | 80.9512 | 96.2986 | 0.000 |
| 2 | 96.9292 | 81.5819 | **80.9512** | 96.2986 | 0.000 |
| 2 | 96.9292 | 81.5819 | 80.9512 | **96.2986** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **96.9292** | 81.5819 | 80.9512 | 96.2986 |
| 2 | 96.9292 | **81.5819** | 80.9512 | 96.2986 |
| 2 | 96.9292 | 81.5819 | **80.9512** | 96.2986 |
| 2 | 96.9292 | 81.5819 | 80.9512 | **96.2986** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.803 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 81.356 | 110.319 | 167.995 | 116.208 |
| 2 | 24.116 | 559.135 | 846.152 | 34.771 |
| 4 | 30.319 | 702.940 | 1063.771 | 43.714 |
| 5 | 681.230 | 7889.618 | 20948.042 | 1249.912 |
| 6 | 1463.993 | 1664.736 | 2699.240 | 1245.170 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -7.012 kN

Governing Restoring Force : 169.098 kN Minimum Sliding Ratio for the Critical Load Case : 24.116

Critical Load Case for Overturning about X-Direction : 1

Governing Overturning Moment : -1.489 kNm Governing Resisting Moment : 250.091 kNm

Minimum Overturning Ratio for the Critical Load Case : 167.995

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 1

Governing Disturbing Force : -1.163 kN

Governing Restoring Force : 128.254 kN Minimum Sliding Ratio for the Critical Load Case : 110.319

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 9.483 kNm Governing Resisting Moment : 329.734 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.771

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 44.724 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 426.508437 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 54.217 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

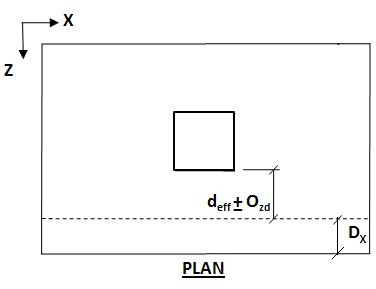
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 426.508437 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

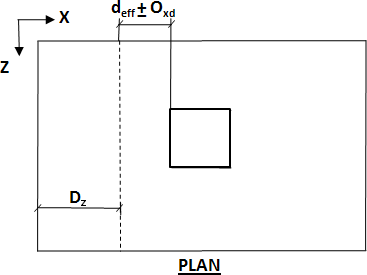
Shear Force(S) = 79.193 kN

Shear Stress(Tv) = 161.158403 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

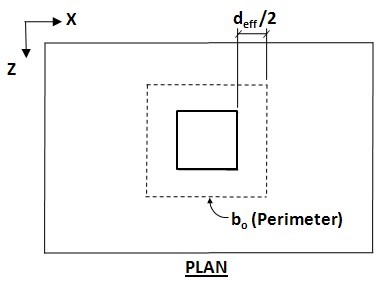
DZ = 0.252 m

Shear Force(S) = 92.789 kN

Shear Stress(Tv) = 188.826033 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 274.837 kN Shear Stress(Tv) = 418.184 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.750 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.700 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 500.011 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 608.412 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 713.700 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.646 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 73.760 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 713.700 mm2 Calculated Area of Steel (Ast) = 713.700 mm2 Provided Area of Steel (Ast,Provided) = 713.700 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 5.287 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.760 mm

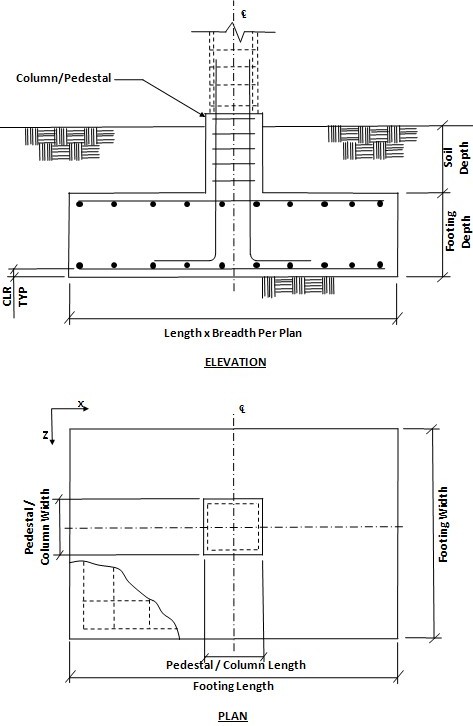
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 41**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.815 | 0.014 | -0.813 | -0.786 | 0.089 |
| 2 | 483.319 | -0.017 | -3.554 | -3.431 | 0.399 |
| 4 | 120.830 | -0.004 | -0.889 | -0.858 | 0.100 |
| 5 | 0.019 | -0.002 | -0.000 | -0.000 | 0.002 |
| 6 | 0.015 | 0.008 | 0.019 | 0.016 | -0.018 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.815 | 0.014 | -0.813 | -0.786 | 0.089 |
| 2 | 483.319 | -0.017 | -3.554 | -3.431 | 0.399 |
| 4 | 120.830 | -0.004 | -0.889 | -0.858 | 0.100 |
| 5 | 0.019 | -0.002 | -0.000 | -0.000 | 0.002 |
| 6 | 0.015 | 0.008 | 0.019 | 0.016 | -0.018 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 4.909 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

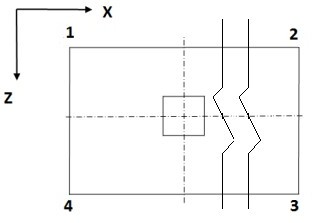
Final Footing Size

Length (L2) = 2.350 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 2.350 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 5.523 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **97.4173** | 97.0436 | 92.8689 | 93.2426 | 0.000 |
| 2 | 97.4173 | **97.0436** | 92.8689 | 93.2426 | 0.000 |
| 2 | 97.4173 | 97.0436 | **92.8689** | 93.2426 | 0.000 |
| 2 | 97.4173 | 97.0436 | 92.8689 | **93.2426** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **97.4173** | 97.0436 | 92.8689 | 93.2426 |
| 2 | 97.4173 | **97.0436** | 92.8689 | 93.2426 |
| 2 | 97.4173 | 97.0436 | **92.8689** | 93.2426 |
| 2 | 97.4173 | 97.0436 | 92.8689 | **93.2426** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 8202.213 | 141.322 | 261.332 | 3195.090 |
| 2 | 15705.035 | 73.912 | 136.742 | 1527.682 |
| 4 | 19480.955 | 91.682 | 169.619 | 1894.983 |
| 5 | 11367.505 | 319151.324 | 581467.991 | 23934.439 |
| 6 | 2574.840 | 1127.828 | 2306.021 | 2390.668 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 6

Governing Disturbing Force : 0.008 kN

Governing Restoring Force : 21.062 kN Minimum Sliding Ratio for the Critical Load Case : 2574.840

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -4.515 kNm Governing Resisting Moment : 617.366 kNm

Minimum Overturning Ratio for the Critical Load Case : 136.742

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -3.554 kN

Governing Restoring Force : 262.714 kN Minimum Sliding Ratio for the Critical Load Case : 73.912

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 0.404 kNm Governing Resisting Moment : 617.366 kNm

Minimum Overturning Ratio for the Critical Load Case : 1527.682

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 94.422 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 102.989 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

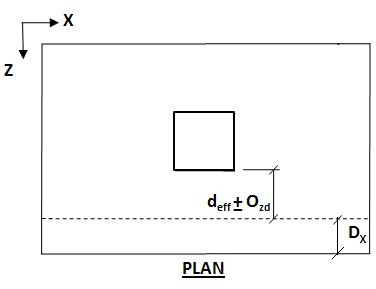
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

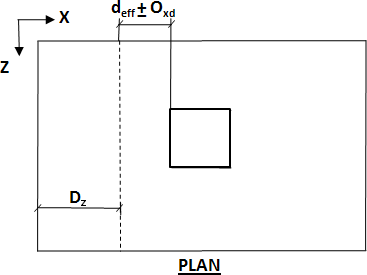
Shear Force(S) = 145.963 kN

Shear Stress(Tv) = 246.475544 kN/m2

Percentage Of Steel(Pt) = 0.1976

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 329.021 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

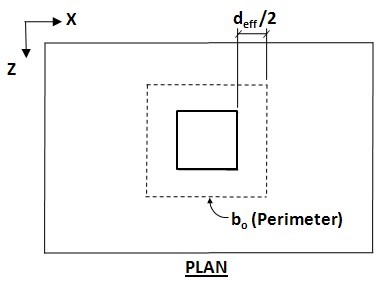
DZ = 0.252 m

Shear Force(S) = 154.063 kN

Shear Stress(Tv) = 260.153937 kN/m2 Percentage Of Steel(Pt) = 0.1807

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 316.186 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 446.333 kN Shear Stress(Tv) = 679.127 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.950 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.900 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1069.887 mm2

Provided Area of Steel (Ast,Provided) = 1069.887 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 60.649 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 60.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1170.355 mm2

Provided Area of Steel (Ast,Provided) = 1170.355 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 54.732 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 8.984 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.800 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 9.955 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.800 mm

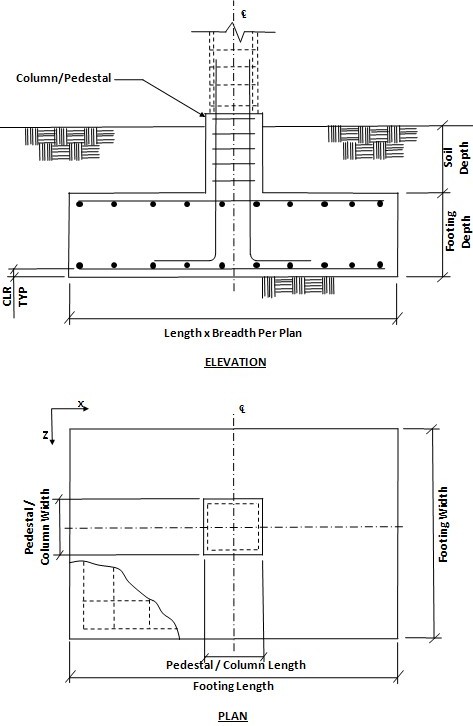
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 42**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.882 | -0.167 | -0.815 | -0.787 | 0.246 |
| 2 | 484.951 | -0.610 | -3.572 | -3.448 | 0.901 |
| 4 | 121.238 | -0.153 | -0.893 | -0.862 | 0.225 |
| 5 | 0.018 | 0.023 | -0.000 | -0.000 | -0.018 |
| 6 | 0.015 | 0.008 | 0.019 | 0.016 | -0.019 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 187.882 | -0.167 | -0.815 | -0.787 | 0.246 |
| 2 | 484.951 | -0.610 | -3.572 | -3.448 | 0.901 |
| 4 | 121.238 | -0.153 | -0.893 | -0.862 | 0.225 |
| 5 | 0.018 | 0.023 | -0.000 | -0.000 | -0.018 |
| 6 | 0.015 | 0.008 | 0.019 | 0.016 | -0.019 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 4.926 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

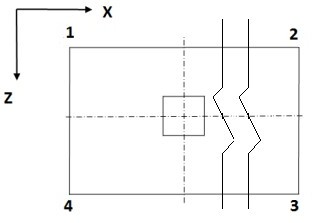
Final Footing Size

Length (L2) = 2.350 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 2.350 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 5.523 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **98.0388** | 97.0338 | 92.8386 | 93.8436 | 0.000 |
| 2 | 98.0388 | **97.0338** | 92.8386 | 93.8436 | 0.000 |
| 2 | 98.0388 | 97.0338 | **92.8386** | 93.8436 | 0.000 |
| 2 | 98.0388 | 97.0338 | 92.8386 | **93.8436** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **98.0388** | 97.0338 | 92.8386 | 93.8436 |
| 2 | 98.0388 | **97.0338** | 92.8386 | 93.8436 |
| 2 | 98.0388 | 97.0338 | **92.8386** | 93.8436 |
| 2 | 98.0388 | 97.0338 | 92.8386 | **93.8436** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 5.523 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 687.193 | 141.083 | 260.879 | 909.332 |
| 2 | 432.004 | 73.782 | 136.497 | 569.792 |
| 4 | 535.549 | 91.467 | 169.212 | 706.362 |
| 5 | 916.130 | 421273.299 | 808156.949 | 1952.604 |
| 6 | 2503.239 | 1131.041 | 2325.220 | 2336.354 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -0.610 kN

Governing Restoring Force : 263.530 kN Minimum Sliding Ratio for the Critical Load Case : 432.004

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -4.537 kNm Governing Resisting Moment : 619.284 kNm

Minimum Overturning Ratio for the Critical Load Case : 136.497

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -3.572 kN

Governing Restoring Force : 263.530 kN Minimum Sliding Ratio for the Critical Load Case : 73.782

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 1.087 kNm Governing Resisting Moment : 619.284 kNm

Minimum Overturning Ratio for the Critical Load Case : 569.792

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 94.744 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 103.602 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

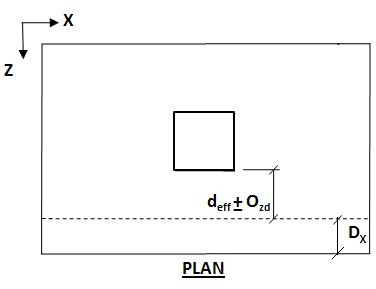
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 513.997347 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

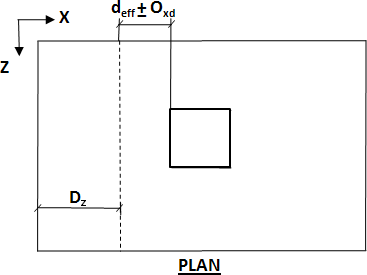
Shear Force(S) = 146.460 kN

Shear Stress(Tv) = 247.314299 kN/m2

Percentage Of Steel(Pt) = 0.1988

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 329.915 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

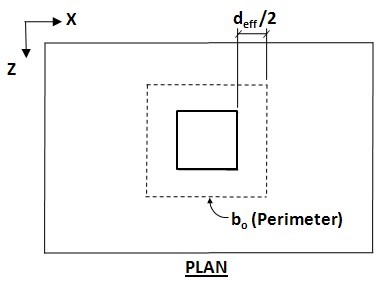
DZ = 0.252 m

Shear Force(S) = 154.961 kN

Shear Stress(Tv) = 261.670094 kN/m2 Percentage Of Steel(Pt) = 0.1813

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 316.680 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 447.841 kN Shear Stress(Tv) = 681.421 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.950 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 20 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.806 m

Allowable Length(ldb) = = 0.900 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1073.646 mm2

Provided Area of Steel (Ast,Provided) = 1073.646 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 60.649 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 60.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 1177.566 mm2

Provided Area of Steel (Ast,Provided) = 1177.566 mm2 Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 54.732 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 8.984 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.800 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 860.100 mm2 Calculated Area of Steel (Ast) = 860.100 mm2 Provided Area of Steel (Ast,Provided) = 860.100 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 9.955 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.800 mm

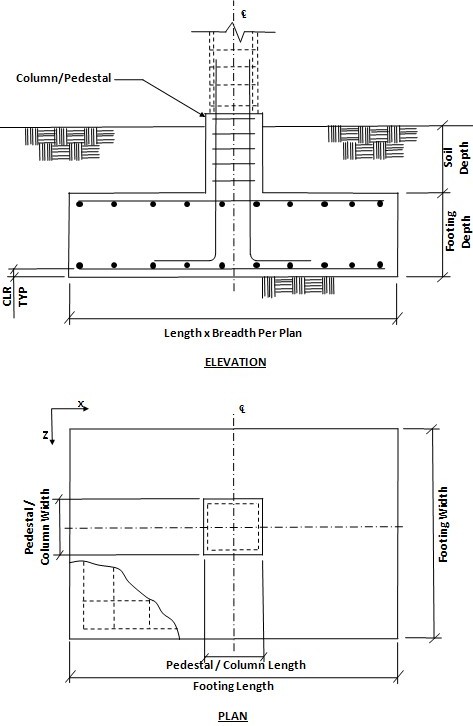
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 43**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 149.351 | 2.503 | -1.330 | -1.301 | -2.398 |
| 2 | 234.210 | 9.466 | -1.851 | -1.806 | -9.076 |
| 4 | 58.553 | 2.367 | -0.463 | -0.451 | -2.269 |
| 5 | -0.029 | 0.059 | -0.004 | -0.004 | -0.051 |
| 6 | 0.016 | 0.006 | 0.006 | 0.005 | -0.016 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 149.351 | 2.503 | -1.330 | -1.301 | -2.398 |
| 2 | 234.210 | 9.466 | -1.851 | -1.806 | -9.076 |
| 4 | 58.553 | 2.367 | -0.463 | -0.451 | -2.269 |
| 5 | -0.029 | 0.059 | -0.004 | -0.004 | -0.051 |
| 6 | 0.016 | 0.006 | 0.006 | 0.005 | -0.016 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.418 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

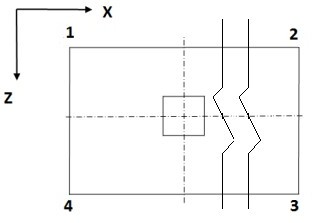
Final Footing Size

Length (L2) = 1.800 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.800 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.240 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **70.0428** | 94.6587 | 89.7815 | 65.1656 | 0.000 |
| 2 | 70.0428 | **94.6587** | 89.7815 | 65.1656 | 0.000 |
| 2 | 70.0428 | 94.6587 | **89.7815** | 65.1656 | 0.000 |
| 2 | 70.0428 | 94.6587 | 89.7815 | **65.1656** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **70.0428** | 94.6587 | 89.7815 | 65.1656 |
| 2 | 70.0428 | **94.6587** | 89.7815 | 65.1656 |
| 2 | 70.0428 | 94.6587 | **89.7815** | 65.1656 |
| 2 | 70.0428 | 94.6587 | 89.7815 | **65.1656** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.240 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 34.763 | 65.434 | 91.791 | 49.548 |
| 2 | 13.676 | 69.928 | 98.309 | 19.478 |
| 4 | 17.590 | 89.945 | 126.450 | 25.054 |
| 5 | 208.720 | 2860.626 | 4594.672 | 321.969 |
| 6 | 2055.291 | 2007.230 | 3037.734 | 1217.701 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : 9.466 kN

Governing Restoring Force : 129.458 kN Minimum Sliding Ratio for the Critical Load Case : 13.676

Critical Load Case for Overturning about X-Direction : 1

Governing Overturning Moment : -1.707 kNm Governing Resisting Moment : 156.647 kNm

Minimum Overturning Ratio for the Critical Load Case : 91.791

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 1

Governing Disturbing Force : -1.330 kN

Governing Restoring Force : 87.028 kN Minimum Sliding Ratio for the Critical Load Case : 65.434

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : -11.963 kNm Governing Resisting Moment : 233.020 kNm

Minimum Overturning Ratio for the Critical Load Case : 19.478

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 30.391 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 393.700096 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 38.459 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

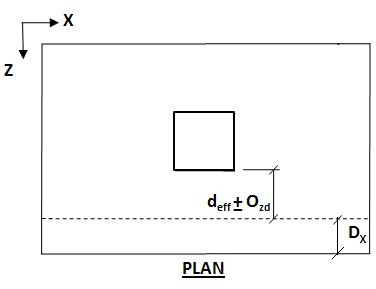
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 393.700096 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

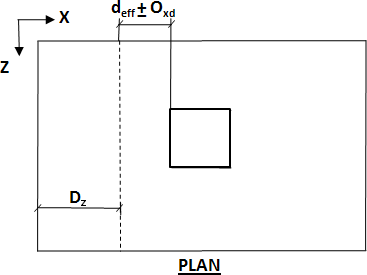
Shear Force(S) = 56.460 kN

Shear Stress(Tv) = 124.470579 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

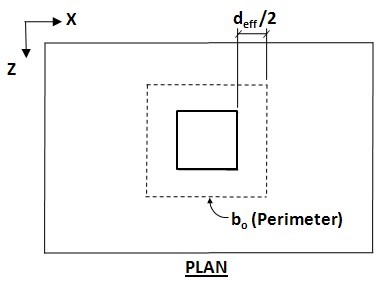
DZ = 0.252 m

Shear Force(S) = 69.271 kN

Shear Stress(Tv) = 152.713017 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 203.662 kN Shear Stress(Tv) = 309.885 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.484 m

Allowable Length(ldb) = = 0.625 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 338.221 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 429.452 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 658.800 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 3.474 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 73.652 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 658.800 mm2 Calculated Area of Steel (Ast) = 658.800 mm2 Provided Area of Steel (Ast,Provided) = 658.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.008 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 73.652 mm

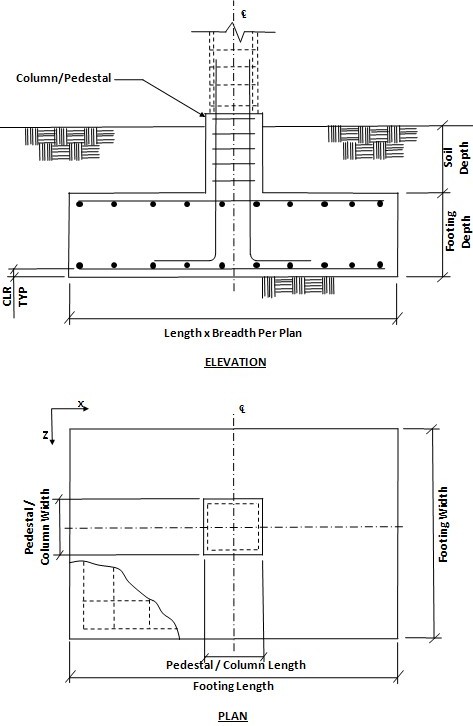
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 44**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1124.187 | -1.923 | 0.953 | 0.914 | 1.963 |
| 2 | 141.831 | -5.712 | 3.134 | 3.022 | 5.874 |
| 4 | 35.458 | -1.428 | 0.784 | 0.756 | 1.468 |
| 5 | 0.011 | -0.021 | -0.019 | -0.016 | 0.028 |
| 6 | 0.016 | -0.001 | 0.025 | 0.022 | 0.015 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1124.187 | -1.923 | 0.953 | 0.914 | 1.963 |
| 2 | 141.831 | -5.712 | 3.134 | 3.022 | 5.874 |
| 4 | 35.458 | -1.428 | 0.784 | 0.756 | 1.468 |
| 5 | 0.011 | -0.021 | -0.019 | -0.016 | 0.028 |
| 6 | 0.016 | -0.001 | 0.025 | 0.022 | 0.015 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 11.318 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

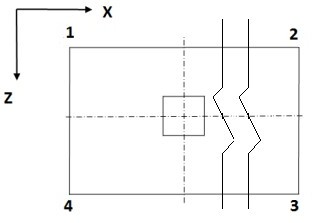
Final Footing Size

Length (L2) = 3.500 m Governing Load Case : # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 3.500 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.406 | m | Governing Load Case : | # 1 |

Area (A2) = 12.250 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **99.5836** | 98.8701 | 99.2072 | 99.9207 | 0.000 |
| 1 | 99.5836 | **98.8701** | 99.2072 | 99.9207 | 0.000 |
| 1 | 99.5836 | 98.8701 | **99.2072** | 99.9207 | 0.000 |
| 1 | 99.5836 | 98.8701 | 99.2072 | **99.9207** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 1 | **99.5836** | 98.8701 | 99.2072 | 99.9207 |
| 1 | 99.5836 | **98.8701** | 99.2072 | 99.9207 |
| 1 | 99.5836 | 98.8701 | **99.2072** | 99.9207 |
| 1 | 99.5836 | 98.8701 | 99.2072 | **99.9207** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 316.553 | 639.096 | 1769.158 | 835.861 |
| 2 | 20.591 | 37.526 | 103.483 | 54.054 |
| 4 | 45.120 | 82.227 | 226.754 | 118.444 |
| 5 | 2272.599 | 2417.636 | 7333.729 | 4779.761 |
| 6 | 43250.878 | 1904.937 | 5609.499 | 10818.874 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -5.712 kN

Governing Restoring Force : 117.619 kN Minimum Sliding Ratio for the Critical Load Case : 20.591

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 3.978 kNm Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 103.483

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 3.134 kN

Governing Restoring Force : 117.619 kN Minimum Sliding Ratio for the Critical Load Case : 37.526

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 7.616 kNm Governing Resisting Moment : 411.657 kNm

Minimum Overturning Ratio for the Critical Load Case : 54.054

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 373.971 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 399.460 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

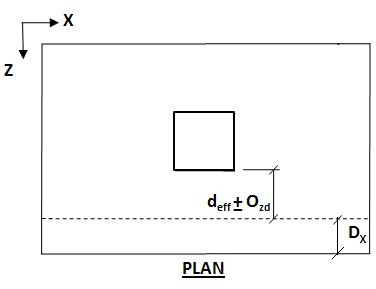
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

DX = 0.352 m

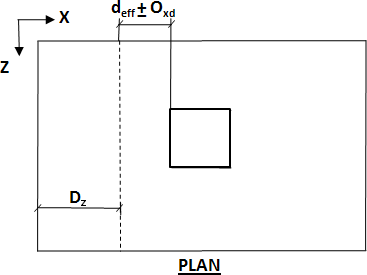
Shear Force(S) = 377.223 kN

Shear Stress(Tv) = 306.187772 kN/m2

Percentage Of Steel(Pt) = 0.2670

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 375.288 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

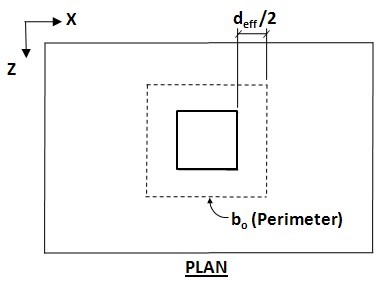
DZ = 0.352 m

Shear Force(S) = 393.817 kN

Shear Stress(Tv) = 319.656277 kN/m2 Percentage Of Steel(Pt) = 0.2492

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 364.214 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 1072.520 kN Shear Stress(Tv) = 1012.943 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.525 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.475 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3069.591 mm2 Provided Area of Steel (Ast,Provided) = 3069.591 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = 48.000 mm

Selected spacing (S) = 55.607 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 55.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3288.947 mm2 Provided Area of Steel (Ast,Provided) = 3288.947 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 52.185 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 34.480 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 75.422 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 36.778 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 75.422 mm

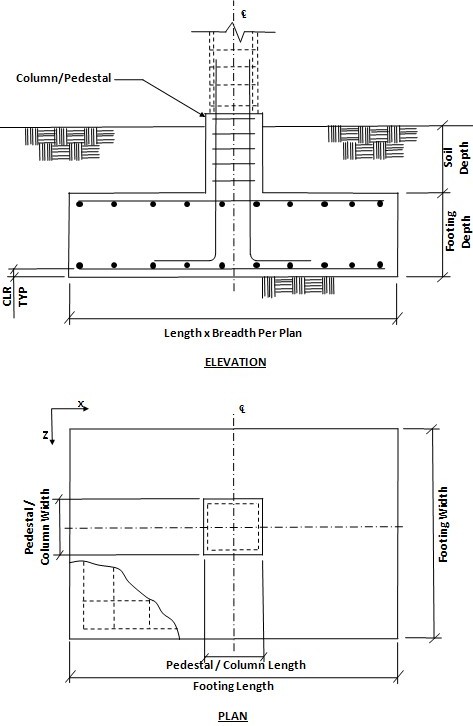
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

**Isolated Footing 45**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.114 | 0.550 | 1.551 | 1.528 | -0.473 |
| 2 | 290.751 | 0.032 | 6.770 | 6.676 | 0.226 |
| 4 | 72.688 | 0.008 | 1.692 | 1.669 | 0.056 |
| 5 | 0.005 | -0.011 | -0.000 | -0.000 | 0.019 |
| 6 | -0.020 | -0.008 | 0.077 | 0.067 | 0.021 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.114 | 0.550 | 1.551 | 1.528 | -0.473 |
| 2 | 290.751 | 0.032 | 6.770 | 6.676 | 0.226 |
| 4 | 72.688 | 0.008 | 1.692 | 1.669 | 0.056 |
| 5 | 0.005 | -0.011 | -0.000 | -0.000 | 0.019 |
| 6 | -0.020 | -0.008 | 0.077 | 0.067 | 0.021 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.984 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

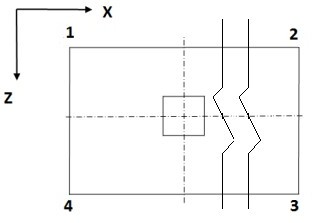
Final Footing Size

Length (L2) = 1.900 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.900 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.610 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **80.7086** | 80.3304 | 95.6224 | 96.0005 | 0.000 |
| 2 | 80.7086 | **80.3304** | 95.6224 | 96.0005 | 0.000 |
| 2 | 80.7086 | 80.3304 | **95.6224** | 96.0005 | 0.000 |
| 2 | 80.7086 | 80.3304 | 95.6224 | **96.0005** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **80.7086** | 80.3304 | 95.6224 | 96.0005 |
| 2 | 80.7086 | **80.3304** | 95.6224 | 96.0005 |
| 2 | 80.7086 | 80.3304 | **95.6224** | 96.0005 |
| 2 | 80.7086 | 80.3304 | 95.6224 | **96.0005** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 185.211 | 65.647 | 96.663 | 302.094 |
| 2 | 5040.980 | 23.508 | 34.593 | 1398.837 |
| 4 | 6349.090 | 29.607 | 43.568 | 1761.787 |
| 5 | 1248.120 | 60641.051 | 86824.191 | 1152.950 |
| 6 | 1628.733 | 178.247 | 287.499 | 1094.508 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 1

Governing Disturbing Force : 0.550 kN

Governing Restoring Force : 101.820 kN Minimum Sliding Ratio for the Critical Load Case : 185.211

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 8.740 kNm Governing Resisting Moment : 302.358 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.593

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 6.770 kN

Governing Restoring Force : 159.139 kN Minimum Sliding Ratio for the Critical Load Case : 23.508

Critical Load Case for Overturning about Z-Direction : 1

Governing Overturning Moment : -0.640 kNm Governing Resisting Moment : 193.455 kNm

Minimum Overturning Ratio for the Critical Load Case : 302.094

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 43.067 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 46.034 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

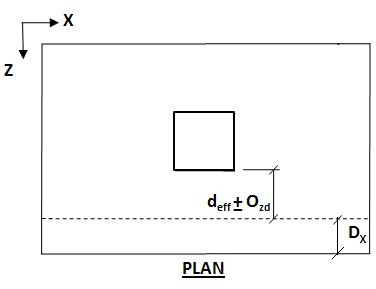
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

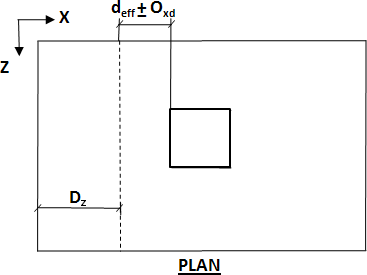
Shear Force(S) = 77.543 kN

Shear Stress(Tv) = 161.951812 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

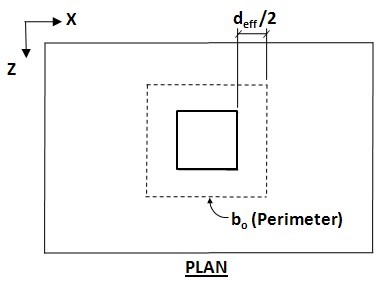
DZ = 0.252 m

Shear Force(S) = 80.169 kN

Shear Stress(Tv) = 167.437847 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 256.714 kN Shear Stress(Tv) = 390.609 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.725 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 481.382 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 515.159 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.230 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.834 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

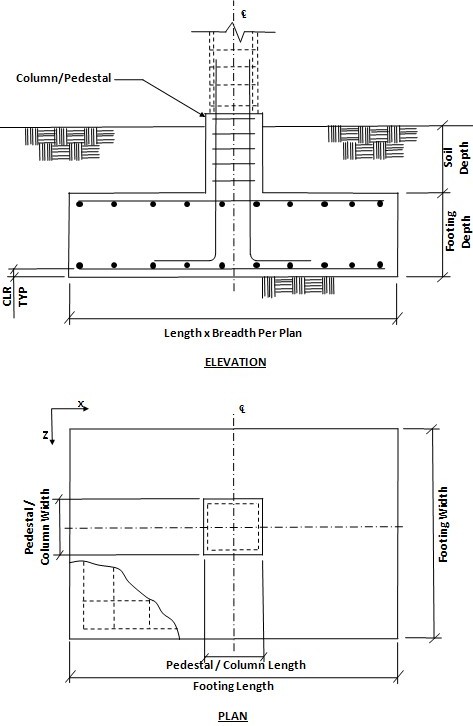
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 46**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.174 | -0.668 | 1.551 | 1.528 | 0.729 |
| 2 | 290.811 | -0.461 | 6.770 | 6.676 | 0.699 |
| 4 | 72.703 | -0.115 | 1.693 | 1.669 | 0.175 |
| 5 | 0.004 | -0.003 | -0.000 | -0.000 | 0.013 |
| 6 | -0.021 | -0.014 | 0.077 | 0.067 | 0.026 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 176.174 | -0.668 | 1.551 | 1.528 | 0.729 |
| 2 | 290.811 | -0.461 | 6.770 | 6.676 | 0.699 |
| 4 | 72.703 | -0.115 | 1.693 | 1.669 | 0.175 |
| 5 | 0.004 | -0.003 | -0.000 | -0.000 | 0.013 |
| 6 | -0.021 | -0.014 | 0.077 | 0.067 | 0.026 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 2.984 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

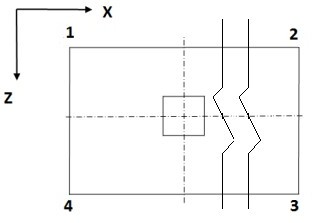
Final Footing Size

Length (L2) = 1.900 m Governing Load Case : # 2

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.900 | m | Governing Load Case : | # 2 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 2 |

Area (A2) = 3.610 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 2 | **81.2696** | 79.8008 | 95.0945 | 96.5633 | 0.000 |
| 2 | 81.2696 | **79.8008** | 95.0945 | 96.5633 | 0.000 |
| 2 | 81.2696 | 79.8008 | **95.0945** | 96.5633 | 0.000 |
| 2 | 81.2696 | 79.8008 | 95.0945 | **96.5633** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 2 | **81.2696** | 79.8008 | 95.0945 | 96.5633 |
| 2 | 81.2696 | **79.8008** | 95.0945 | 96.5633 |
| 2 | 81.2696 | 79.8008 | **95.0945** | 96.5633 |
| 2 | 81.2696 | 79.8008 | 95.0945 | **96.5633** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 3.610 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 152.361 | 65.688 | 96.726 | 207.481 |
| 2 | 345.205 | 23.509 | 34.595 | 360.226 |
| 4 | 434.754 | 29.608 | 43.570 | 453.670 |
| 5 | 4045.039 | 72448.775 | 109913.878 | 1888.797 |
| 6 | 966.397 | 178.314 | 288.935 | 858.576 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 1

Governing Disturbing Force : -0.668 kN

Governing Restoring Force : 101.850 kN Minimum Sliding Ratio for the Critical Load Case : 152.361

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 8.741 kNm Governing Resisting Moment : 302.415 kNm

Minimum Overturning Ratio for the Critical Load Case : 34.595

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 6.770 kN

Governing Restoring Force : 159.169 kN Minimum Sliding Ratio for the Critical Load Case : 23.509

Critical Load Case for Overturning about Z-Direction : 1

Governing Overturning Moment : 0.933 kNm Governing Resisting Moment : 193.512 kNm

Minimum Overturning Ratio for the Critical Load Case : 207.481

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 43.075 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #2

Effective Depth =  = 0.252 m Governing moment (Mu) = 46.270 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

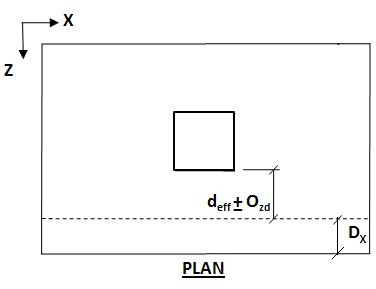
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 415.572323 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #2

DX = 0.252 m

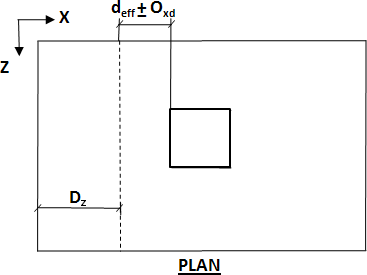
Shear Force(S) = 77.558 kN

Shear Stress(Tv) = 161.984176 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #2

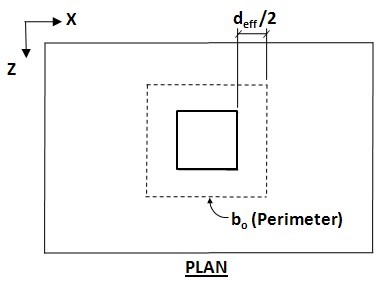
DZ = 0.252 m

Shear Force(S) = 80.578 kN

Shear Stress(Tv) = 168.292475 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #2

Shear Force(S) = 256.767 kN Shear Stress(Tv) = 390.689 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.725 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 16 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.645 m

Allowable Length(ldb) = = 0.675 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 481.480 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #2

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 517.849 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.230 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.750 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 695.400 mm2 Calculated Area of Steel (Ast) = 695.400 mm2 Provided Area of Steel (Ast,Provided) = 695.400 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 4.834 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.750 mm

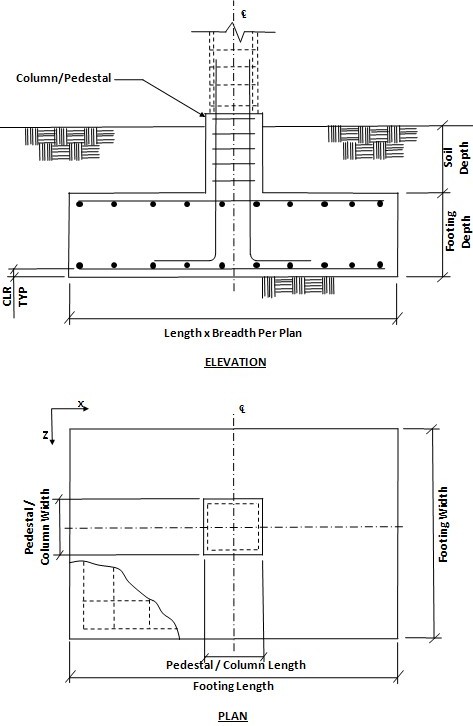
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 47**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1123.359 | 1.823 | 0.899 | 0.861 | -1.725 |
| 2 | 140.963 | 5.327 | 3.098 | 2.984 | -4.993 |
| 4 | 35.241 | 1.332 | 0.774 | 0.746 | -1.248 |
| 5 | -0.011 | 0.006 | -0.021 | -0.018 | 0.004 |
| 6 | -0.017 | -0.022 | 0.022 | 0.019 | 0.033 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 1123.359 | 1.823 | 0.899 | 0.861 | -1.725 |
| 2 | 140.963 | 5.327 | 3.098 | 2.984 | -4.993 |
| 4 | 35.241 | 1.332 | 0.774 | 0.746 | -1.248 |
| 5 | -0.011 | 0.006 | -0.021 | -0.018 | 0.004 |
| 6 | -0.017 | -0.022 | 0.022 | 0.019 | 0.033 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 11.310 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

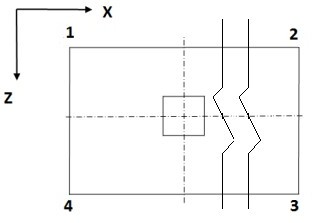
Final Footing Size

Length (L2) = 3.500 m Governing Load Case : # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 3.500 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.406 | m | Governing Load Case : | # 1 |

Area (A2) = 12.250 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **98.8498** | 99.4881 | 99.8058 | 99.1674 | 0.000 |
| 1 | 98.8498 | **99.4881** | 99.8058 | 99.1674 | 0.000 |
| 1 | 98.8498 | 99.4881 | **99.8058** | 99.1674 | 0.000 |
| 1 | 98.8498 | 99.4881 | 99.8058 | **99.1674** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 1 | **98.8498** | 99.4881 | 99.8058 | 99.1674 |
| 1 | 98.8498 | **99.4881** | 99.8058 | 99.1674 |
| 1 | 98.8498 | 99.4881 | **99.8058** | 99.1674 |
| 1 | 98.8498 | 99.4881 | 99.8058 | **99.1674** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 12.250 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 333.745 | 676.535 | 1876.225 | 933.629 |
| 2 | 21.998 | 37.831 | 104.388 | 61.977 |
| 4 | 48.299 | 83.063 | 229.196 | 136.078 |
| 5 | 7866.826 | 2207.605 | 6615.266 | 64031.297 |
| 6 | 2137.349 | 2150.242 | 6400.943 | 4125.248 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : 5.327 kN

Governing Restoring Force : 117.185 kN Minimum Sliding Ratio for the Critical Load Case : 21.998

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 3.929 kNm Governing Resisting Moment : 410.139 kNm

Minimum Overturning Ratio for the Critical Load Case : 104.388

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 3.098 kN

Governing Restoring Force : 117.185 kN Minimum Sliding Ratio for the Critical Load Case : 37.831

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : -6.618 kNm Governing Resisting Moment : 410.139 kNm

Minimum Overturning Ratio for the Critical Load Case : 61.977

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 373.668 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.352 m Governing moment (Mu) = 399.053 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

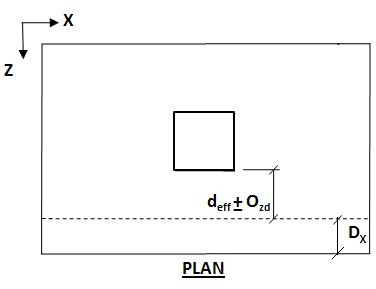
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 1493.637811 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

DX = 0.352 m

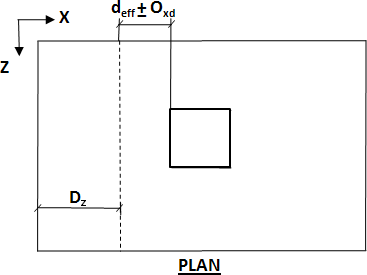
Shear Force(S) = 376.919 kN

Shear Stress(Tv) = 305.940913 kN/m2

Percentage Of Steel(Pt) = 0.2667

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 375.114 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

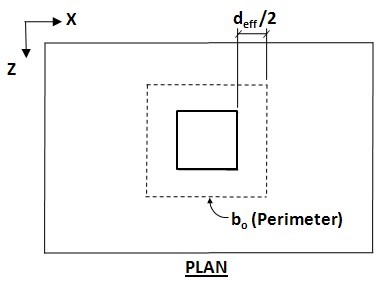
DZ = 0.352 m

Shear Force(S) = 393.422 kN

Shear Stress(Tv) = 319.336431 kN/m2 Percentage Of Steel(Pt) = 0.2489

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 364.080 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 1071.730 kN Shear Stress(Tv) = 1012.196 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.525 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 32 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 1.289 m

Allowable Length(ldb) = = 1.475 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3066.990 mm2 Provided Area of Steel (Ast,Provided) = 3066.990 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = 48.000 mm

Selected spacing (S) = 55.607 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 55.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 3285.435 mm2 Provided Area of Steel (Ast,Provided) = 3285.435 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø8 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 52.185 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø8 @ 50.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 34.480 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 75.422 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 1705.200 mm2 Calculated Area of Steel (Ast) = 1281.000 mm2 Provided Area of Steel (Ast,Provided) = 1705.200 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 36.778 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 75.422 mm

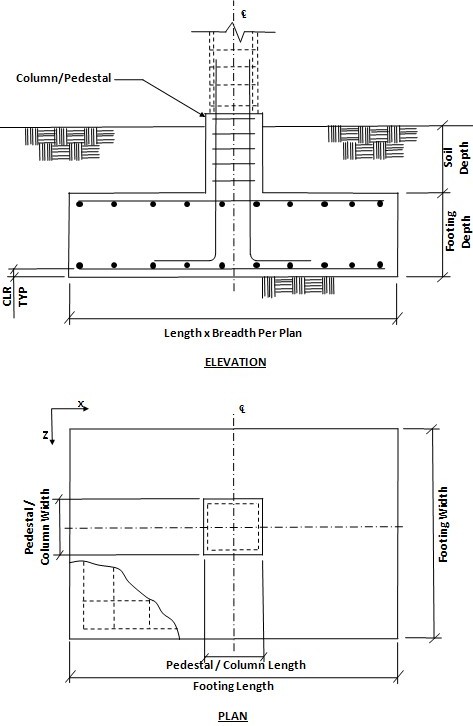
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 75 mm o.c.**

**Isolated Footing 173**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 142.693 | -0.555 | -0.559 | -0.542 | 0.673 |
| 2 | 55.963 | -1.013 | -1.080 | -1.049 | 1.462 |
| 4 | 13.991 | -0.253 | -0.270 | -0.262 | 0.365 |
| 5 | -0.088 | -0.030 | 0.005 | 0.004 | 0.023 |
| 6 | -0.027 | 0.013 | -0.005 | -0.004 | -0.022 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 142.693 | -0.555 | -0.559 | -0.542 | 0.673 |
| 2 | 55.963 | -1.013 | -1.080 | -1.049 | 1.462 |
| 4 | 13.991 | -0.253 | -0.270 | -0.262 | 0.365 |
| 5 | -0.088 | -0.030 | 0.005 | 0.004 | 0.023 |
| 6 | -0.027 | 0.013 | -0.005 | -0.004 | -0.022 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 1.503 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

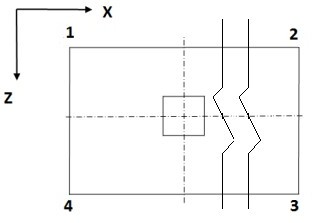
Final Footing Size

Length (L2) = 1.300 m Governing Load Case : # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.300 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 1 |

Area (A2) = 1.690 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **96.3044** | 91.7057 | 87.8130 | 92.4117 | 0.000 |
| 1 | 96.3044 | **91.7057** | 87.8130 | 92.4117 | 0.000 |
| 1 | 96.3044 | 91.7057 | **87.8130** | 92.4117 | 0.000 |
| 1 | 96.3044 | 91.7057 | 87.8130 | **92.4117** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 1 | **96.3044** | 91.7057 | 87.8130 | 92.4117 |
| 1 | 96.3044 | **91.7057** | 87.8130 | 92.4117 |
| 1 | 96.3044 | 91.7057 | **87.8130** | 92.4117 |
| 1 | 96.3044 | 91.7057 | 87.8130 | **92.4117** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 1.690 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 140.248 | 139.106 | 141.894 | 120.110 |
| 2 | 33.967 | 31.860 | 32.467 | 25.269 |
| 4 | 53.040 | 49.750 | 50.697 | 39.457 |
| 5 | 214.229 | 1318.026 | 1496.233 | 256.589 |
| 6 | 491.414 | 1400.491 | 1505.163 | 317.434 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -1.013 kN

Governing Restoring Force : 34.424 kN Minimum Sliding Ratio for the Critical Load Case : 33.967

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : -1.378 kNm Governing Resisting Moment : 44.751 kNm

Minimum Overturning Ratio for the Critical Load Case : 32.467

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : -1.080 kN

Governing Restoring Force : 34.424 kN Minimum Sliding Ratio for the Critical Load Case : 31.860

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 1.771 kNm Governing Resisting Moment : 44.751 kNm

Minimum Overturning Ratio for the Critical Load Case : 25.269

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.252 m Governing moment (Mu) = 10.092 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 284.338958 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.252 m Governing moment (Mu) = 12.638 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

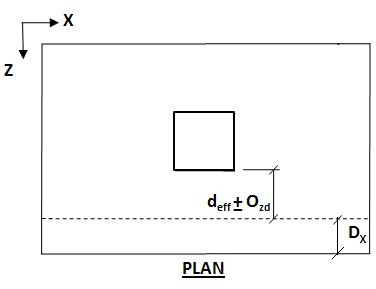
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 284.338958 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

DX = 0.252 m

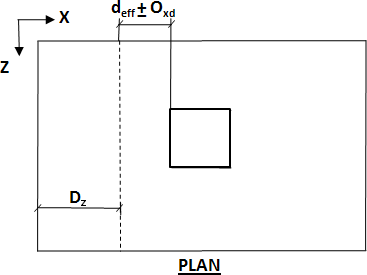
Shear Force(S) = 19.369 kN

Shear Stress(Tv) = 59.122751 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

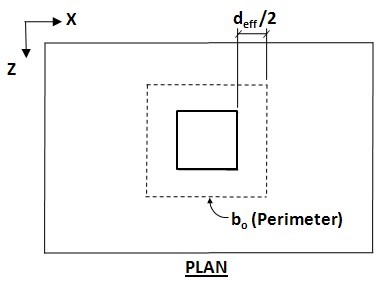
DZ = 0.252 m

Shear Force(S) = 25.030 kN

Shear Stress(Tv) = 76.402807 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 107.011 kN Shear Stress(Tv) = 162.825 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.403 m

Allowable Length(ldb) = = 0.425 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.322 m

Allowable Length(ldb) = = 0.375 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 111.547 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 139.891 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 475.800 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 0.995 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 475.800 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 1.242 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.625 mm

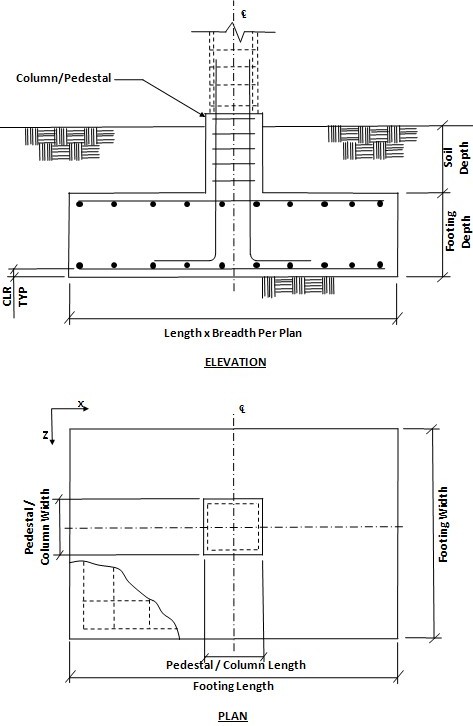
Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

**Isolated Footing 174**



Input Values

Footing Geomtery

Design Type : Calculate Dimension Footing Thickness (Ft) : 305.000 mm Footing Length - X (Fl) : 1000.000 mm Footing Width - Z (Fw) : 1000.000 mm

Eccentricity along X (Oxd) : 0.000 mm Eccentricity along Z (Ozd) : 0.000 mm

### Column Dimensions

Column Shape : Rectangular Column Length - X (Pl) : 0.350 m Column Width - Z (Pw) : 0.450 m

### Pedestal

Include Pedestal? No Pedestal Shape : N/A

Pedestal Height (Ph) : N/A Pedestal Length - X (Pl) : N/A Pedestal Width - Z (Pw) : N/A

## Design Parameters

### Concrete and Rebar Properties

Unit Weight of Concrete : 25.000 kN/m3 Strength of Concrete : 25.000 N/mm2

Yield Strength of Steel : 415.000 N/mm2 Minimum Bar Size : Ø6

Maximum Bar Size : Ø32 Minimum Bar Spacing : 50.000 mm Maximum Bar Spacing : 500.000 mm

Pedestal Clear Cover (P, CL) : 50.000 mm Footing Clear Cover (F, CL) : 50.000 mm

### Soil Properties

Soil Type : Drained

Unit Weight : 22.000 kN/m3 Soil Bearing Capacity : 100.000 kN/m2

Soil Surcharge : 0.000 kN/m2 Depth of Soil above Footing : 0.000 mm

Cohesion : 0.000 kN/m2 Min Percentage of Slab : 0.000

### Sliding and Overturning

Coefficient of Friction : 0.500 Factor of Safety Against Sliding : 1.500 Factor of Safety Against Overturning : 1.500

|  |  |
| --- | --- |
| **Load Combination/s- Service Stress Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |

|  |  |
| --- | --- |
| 6 | W Z |
| **Load Combination/s- Strength Level** | |
| **Load Combination Number** | **Load Combination Title** |
| 1 | DL |
| 2 | LL |
| 4 | FLOOR FINISH |
| 5 | W X |
| 6 | W Z |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Service Stress Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 142.693 | -0.555 | 0.559 | 0.542 | 0.673 |
| 2 | 55.963 | -1.013 | 1.080 | 1.049 | 1.462 |
| 4 | 13.991 | -0.253 | 0.270 | 0.262 | 0.365 |
| 5 | -0.088 | -0.030 | -0.005 | -0.004 | 0.023 |
| 6 | -0.027 | 0.013 | 0.005 | 0.004 | -0.022 |

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Applied Loads - Strength Level | | | | | |
| LC | Axial (kN) | Shear X (kN) | Shear Z (kN) | Moment X (kNm) | Moment Z (kNm) |
| 1 | 142.693 | -0.555 | 0.559 | 0.542 | 0.673 |
| 2 | 55.963 | -1.013 | 1.080 | 1.049 | 1.462 |
| 4 | 13.991 | -0.253 | 0.270 | 0.262 | 0.365 |
| 5 | -0.088 | -0.030 | -0.005 | -0.004 | 0.023 |
| 6 | -0.027 | 0.013 | 0.005 | 0.004 | -0.022 |

### Design Calculations

Footing Size

Initial Length (Lo) = 1.000 m Initial Width (Wo) = 1.000 m

Uplift force due to buoyancy = 0.000 kN Effect due to adhesion = 0.000 kN

Area from initial length and width, Ao = Lo X Wo = 1.000 m2 Min. area required from bearing pressure, Amin = P / qmax = 1.503 m2

**Note: Amin is an initial estimation.**

**P = Critical Factored Axial Load(without self weight/buoyancy/soil). qmax = Respective Factored Bearing Capacity.**

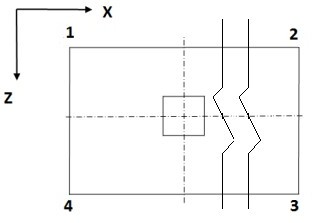
Final Footing Size

Length (L2) = 1.300 m Governing Load Case : # 1

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Width (W2) = | 1.300 | m | Governing Load Case : | # 1 |
| Depth (D2) = | 0.305 | m | Governing Load Case : | # 1 |

Area (A2) = 1.690 m2

Pressures at Four Corner



|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** | **Area of footing in uplift (Au)**  **(m2)** |
| 1 | **92.4117** | 87.8130 | 91.7057 | 96.3044 | 0.000 |
| 1 | 92.4117 | **87.8130** | 91.7057 | 96.3044 | 0.000 |
| 1 | 92.4117 | 87.8130 | **91.7057** | 96.3044 | 0.000 |
| 1 | 92.4117 | 87.8130 | 91.7057 | **96.3044** | 0.000 |

If Au is zero, there is no uplift and no pressure adjustment is necessary. Otherwise, to account for uplift, areas of negative pressure will be set to zero and the pressure will be redistributed to remaining corners.

Summary of adjusted Pressures at Four Corner

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Load Case** | **Pressure at corner 1 (q1)**  **(kN/m2)** | **Pressure at corner 2 (q2)**  **(kN/m2)** | **Pressure at corner 3 (q3)**  **(kN/m2)** | **Pressure at corner 4 (q4)**  **(kN/m2)** |
| 1 | **92.4117** | 87.8130 | 91.7057 | 96.3044 |
| 1 | 92.4117 | **87.8130** | 91.7057 | 96.3044 |
| 1 | 92.4117 | 87.8130 | **91.7057** | 96.3044 |
| 1 | 92.4117 | 87.8130 | 91.7057 | **96.3044** |

Details of Out-of-Contact Area (If Any)

Governing load case = N/A

Plan area of footing = 1.690 sq.m Area not in contact with soil = 0.000 sq.m

% of total area not in contact = 0.000%

Check For Stability Against Overturning And Sliding

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| - | **Factor of safety against sliding** | | **Factor of safety against overturning** | |
| **Load Case No.** | **Along X- Direction** | **Along Z- Direction** | **About X- Direction** | **About Z- Direction** |
| 1 | 140.248 | 139.106 | 141.894 | 120.110 |
| 2 | 33.967 | 31.860 | 32.467 | 25.269 |
| 4 | 53.040 | 49.750 | 50.697 | 39.457 |
| 5 | 214.229 | 1318.026 | 1496.233 | 256.589 |
| 6 | 491.414 | 1400.491 | 1505.163 | 317.434 |

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding X Direction Critical Load Case for Sliding along X-Direction : 2

Governing Disturbing Force : -1.013 kN

Governing Restoring Force : 34.424 kN Minimum Sliding Ratio for the Critical Load Case : 33.967

Critical Load Case for Overturning about X-Direction : 2

Governing Overturning Moment : 1.378 kNm Governing Resisting Moment : 44.751 kNm

Minimum Overturning Ratio for the Critical Load Case : 32.467

Critical Load Case And The Governing Factor Of Safety For Overturning and Sliding Z Direction Critical Load Case for Sliding along Z-Direction : 2

Governing Disturbing Force : 1.080 kN

Governing Restoring Force : 34.424 kN Minimum Sliding Ratio for the Critical Load Case : 31.860

Critical Load Case for Overturning about Z-Direction : 2

Governing Overturning Moment : 1.771 kNm Governing Resisting Moment : 44.751 kNm

Minimum Overturning Ratio for the Critical Load Case : 25.269

### Moment Calculation

Check Trial Depth against moment (w.r.t. X Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.252 m Governing moment (Mu) = 10.092 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 284.338958 kNm

Mu <= Mumax hence, safe

Check Trial Depth against moment (w.r.t. Z Axis)

#### Critical Load Case = #1

Effective Depth =  = 0.252 m Governing moment (Mu) = 12.638 kNm

As Per IS 456 2000 ANNEX G G-1.1C

Limiting Factor1 (Kumax) =  = 0.479107

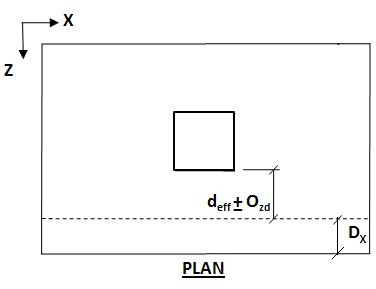
Limiting Factor2 (Rumax) = = 3444.291146 kN/m2

Limit Moment Of Resistance (Mumax) = = 284.338958 kNm

Mu <= Mumax hence, safe

### Shear Calculation

Check Trial Depth for one way shear (Along X Axis) (Shear Plane Parallel to X Axis)



#### Critical Load Case = #1

DX = 0.252 m

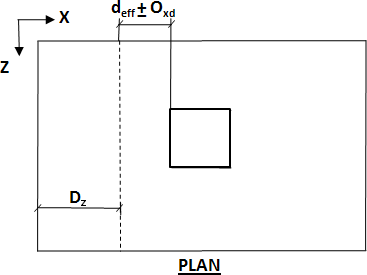
Shear Force(S) = 19.369 kN

Shear Stress(Tv) = 59.122751 kN/m2

Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for one way shear (Along Z Axis) (Shear Plane Parallel to Z Axis)

#### Critical Load Case = #1

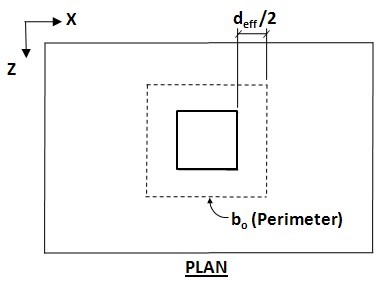
DZ = 0.252 m

Shear Force(S) = 25.030 kN

Shear Stress(Tv) = 76.402807 kN/m2 Percentage Of Steel(Pt) = 0.1452

As Per IS 456 2000 Clause 40 Table 19 Shear Strength Of Concrete(Tc) = 286.768 kN/m2

Tv< Tc hence, safe

Check Trial Depth for two way shear

#### Critical Load Case = #1

Shear Force(S) = 107.011 kN Shear Stress(Tv) = 162.825 kN/m2 As Per IS 456 2000 Clause 31.6.3.1

Ks = = 1.000

Shear Strength(Tc)= = 1250.0000 kN/m2

Ks x Tc = 1250.0000 kN/m2

Tv<= Ks x Tc hence, safe

### Reinforcement Calculation

Calculation of Maximum Bar Size

Along X Axis

Bar diameter corresponding to max bar size (db) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.403 m

Allowable Length(ldb) = = 0.425 m

ldb >=ld hence, safe

Along Z Axis

Bar diameter corresponding to max bar size(db) = 10 mm

As Per IS 456 2000 Clause 26.2.1

Development Length(ld) = = 0.322 m

Allowable Length(ldb) = = 0.375 m

ldb >=ld hence, safe

Bottom Reinforcement Design

Along Z Axis



For moment w.r.t. X Axis (Mx) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 111.551 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 46.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Along X Axis



For moment w.r.t. Z Axis (Mz) As Per IS 456 2000 Clause 26.5.2.1

#### Critical Load Case = #1

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 139.891 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70.000 mm o.c.**

Top Reinforcement Design

Along Z Axis



Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 475.800 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 0.995 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = 50.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Along X Axis

Minimum Area of Steel (Astmin) = 475.800 mm2 Calculated Area of Steel (Ast) = 475.800 mm2 Provided Area of Steel (Ast,Provided) = 475.800 mm2

Astmin<= Ast,Provided Steel area is accepted Governing Moment = 1.242 kNm

Selected bar Size (db) = Ø6 Minimum spacing allowed (Smin) = = 50.000 mm

Selected spacing (S) = 74.625 mm

Smin <= S <= Smax and selected bar size < selected maximum bar size...

The reinforcement is accepted.

#### Based on spacing reinforcement increment; provided reinforcement is

**Ø6 @ 70 mm o.c.**

Print Calculation Sheet