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Analysis of Ring Foundation Using Finite Element Method

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Abstract—***The Finite Element Method (FEM),[Its practical application often known as finite element analysis] is a numerical technique for finding approximate solution to partial differential equation (PDE) and their systems as well as integral equation. In simple terms FEM is method for dividing up a very complicated problem in to small elements that can be solved in relation to each other. The FEM originated from the need for solving complex elasticity and structural analysis problem in civil engineering.***

Index Terms— **Finite element method, Ring foundation.**

I. CONCEPT OF RING FOUNDATION

This type of foundation is mostly common to all project sites. However sometimes design concrete ring beam around the tank foundation. For following criteria prefer the ring foundation:

Water tank foundation
To prevent uplift of the tank due to wind or earthquake
To prevent edge failure of the soil at the tank shell
To prevent local uplift of the tank due to internal pressure

To get safe and economic sizes of footing we have to analyze the footing accurately. Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behavior of structures. To perform an analysis a structural engineers must determine such information as structural loads, geometry, support conditions, and mathematical properties. The results of such an analysis typically include support reactions, Bending and shear stresses and displacements. This information is then compared to criteria that indicate the conditions of failure.

II. TYPES OF ANALYSIS

There are four types of analysis:
Rigid Analysis
Elastic Analysis
Simplified Elastic Approach
Elasto plastic Approach

Rigid Analysis: In rigid analysis the assumption is made that the base pressure or the Bearing pressure is uniform throughout the area and centre of gravity of loading and the centre of gravity of Geometry of footing matches with each other.

Elastic Analysis: In the elastic analysis the soil is assumed as the Homogeneous Elastic and Isotropic Medium and solution of such analysis is obtained using Theory of Elasticity.

Simplified Elastic Approach: In this type of analysis the soil is replaced by Independent Elastic Spring whose stiffness can be approximated by using Modulus of sub grade reaction, Base area and depth of foundation. It also called as Winkler Model.

Elasto-Plastic Approach: A numerical tool like finite element is used to analyze the combine footing by considering the soil as Elasto-Plastic Medium.

III. CONCEPT OF FINITE ELEMENT METHOD

The Finite Element Method (FEM),[Its practical application often known as finite element analysis] is a numerical technique for finding approximate solution to partial differential equation (PDE) and their systems as well as integral equation. In simple terms FEM is method for dividing up a very complicated problem in to small elements that can be solved in relation to each other. The FEM originated from the need for solving complex elasticity and structural analysis problem in civil engineering.

Development of the finite element method began in earnest in the middle to late 1950s for airframe and structural analysis and gathered momentum at the University of Stuttgart through the work of John Argyris and Berkeley through the work of Ray W Clough in the 1960s for use in civil engineering. In present study Analysis of Ring foundation using finite element method will be carried out The objective of this study is to obtain deflection, shear force, twisting moment and bending moment.

The finite-element method (FEM) for a ring foundation is somewhat similar to the beam on-elastic-foundation method. The node and element numbering are rather straightforward, as shown in Fig. The computer program is considerably more lengthy since the P-X coding is somewhat different see figure in order to obtain a bandwidth of bandwidth of 60 is obtained if one proceeds in a continuous manner counterclockwise around the ring from node 1. The element A matrix is to find out the bending moment and other data for a ring foundation.

IV. COMPARATIVE STUDY

Table 1 List of Studied Parameters

1.	Type of Foundation	Ring foundation	
2.	Number of Nodes	8 Nodes	
3.	Sections analysed	With Torsion And Without Torsion	
4.	Load Variable	3 Loaded And 5 Loaded	

A. Comparison of Beam by IS:800-1984 & IS:800-2007

1) Analysis of 8 Noded

a) Three Loaded

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i) 8 Noded with three load without torsion ring foundation

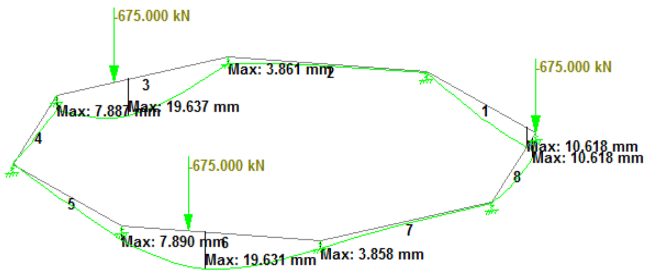

Fig a) Deflected profile for 8 noded ring foundation without torsion

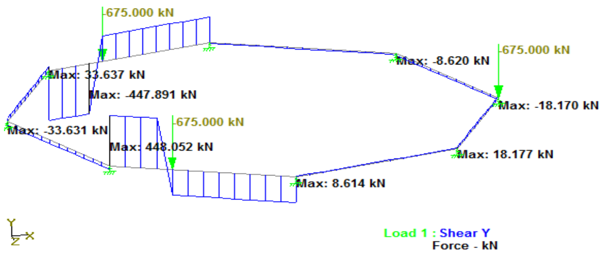

Fig b) SFD for 8 noded ring foundation without torsion

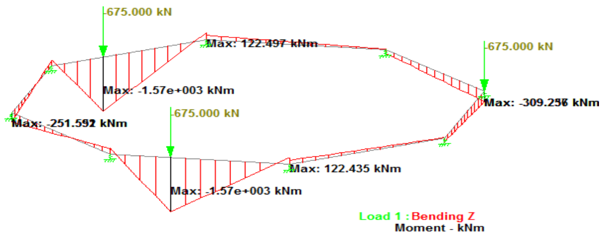

Fig c) BMD for 8 noded ring foundation without torsion

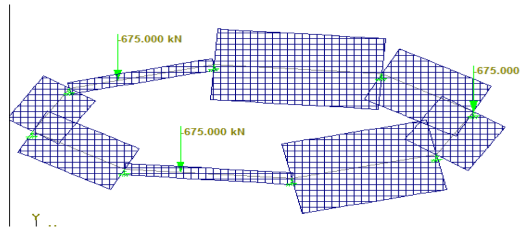

Fig d) TMD for 8 noded ring foundation without torsion

ii) 8 Noded with three load with torsion ring foundation

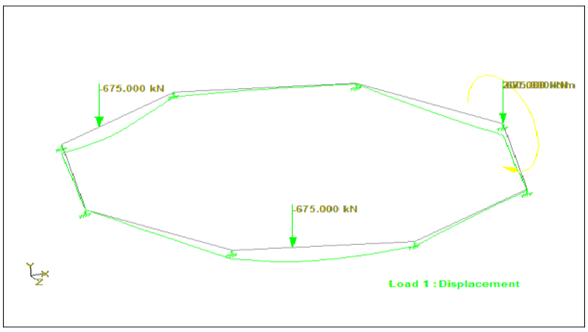

Fig e) Deflected profile for 8 noded ring foundation with torsion

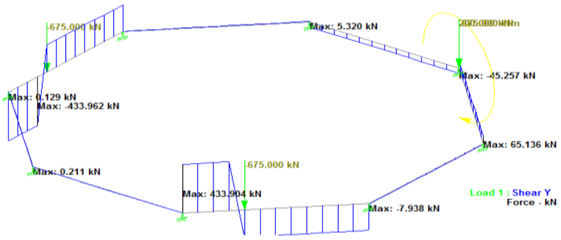

Fig f) SFD for 8 noded ring foundation with torsion

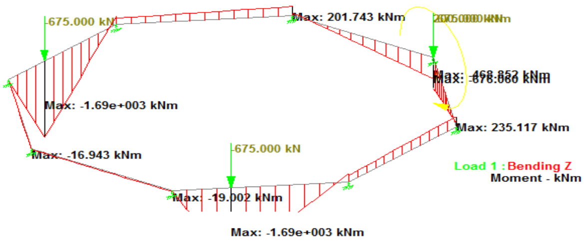

Fig g) BMD for 8 noded ring foundation with torsion

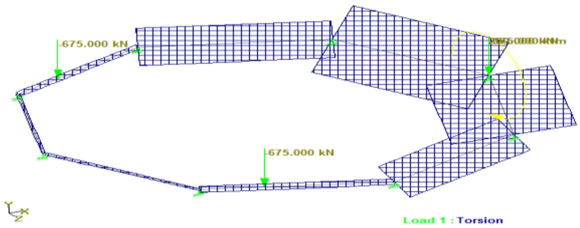

Fig h) TMD for 8 noded ring foundation with torsion

Table 1 8 Noded with three load ring foundation

	WITH TORSION	WITHOUT TORSION
Beam	Max Disp mm	Max Disp mm
1	8.932	3.048
2	4.25	2.439
3	18.759	14.859
4	6.207	0.231
5	6.206	0.254
6	18.696	14.859
7	4.52	2.698
8	7.708	4.405

b) Five Loaded

i) 8 Noded with Five load without torsion ring foundation

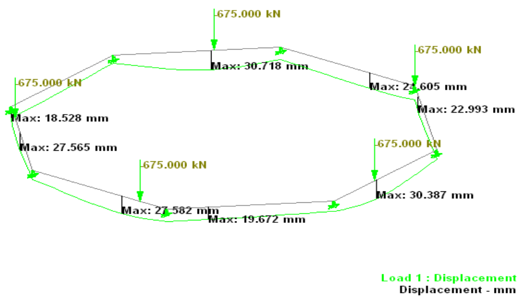

Fig i) Deflected profile for 8 noded ring foundation without torsion

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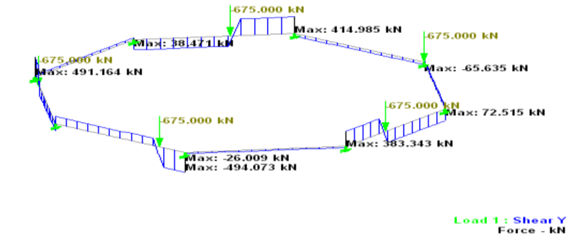

Fig j) SFD for 8 noded ring foundation without torsion

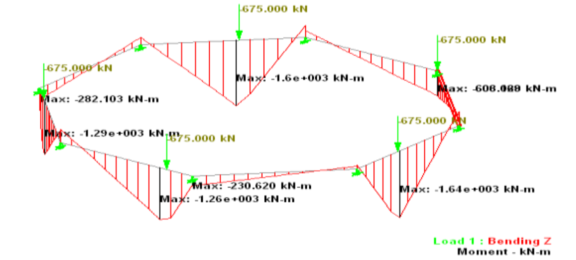

Fig k) BMD for 8 noded ring foundation without torsion

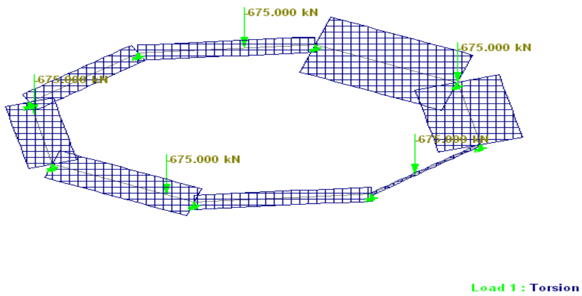

Fig l) TMD for 8 noded ring foundation without torsion

ii) 8 Noded with Five load with torsion ring foundation

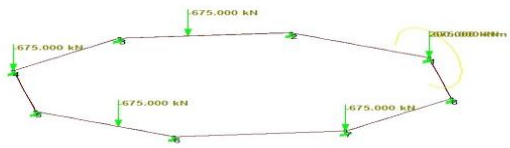

Fig m) Deflected profile for 8 noded ring foundation with torsion

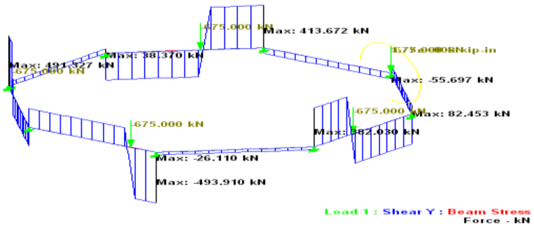

Fig n) SFD for 8 noded ring foundation with torsion

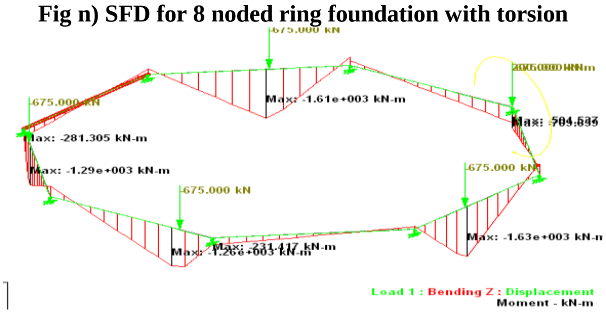

Fig o) BMD for 8 noded ring foundation with torsion

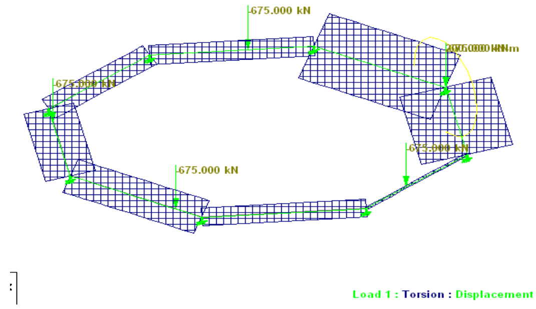

Fig p) TMD for 8 noded ring foundation with torsion

Table 2 8 Noded with Five load ring foundation

	WITH TORSION	WITHOUT TORSION
Beam	Max Disp mm	Max Disp mm
1	2.744	3.423
2	14.461	14.332
3	1.045	1.048
4	10.526	10.537
5	10.151	10.140
6	1.219	1.216
7	14.312	14.441
8	3.581	2.920

V. OBSERVATIONS

1) Maximum values of 8 noded with three loaded ring foundation:- (From fig a,b,c,d,e,f,g,h)

max BMD without torsion= 309.256 kNm
max BMD with torsion = 676.060 kNm
max SFD without torsion = 448.052 kN
max SFD with torsion = 433.962 kN
max DISS without torsion = 14.859 mm
max DISS with torsion =18.759 mm

2)Maximum values of 8 noded with five loaded ring foundation:- (From fig i,j,k,l,m,n,o,p)

max BMD without torsion= 1643.502kNm
max BMD with torsion = 1635.699 kNm
max SFD without torsion = 491.164 kN
max SFD with torsion = 493.910 kN
max DISS without torsion = 14.441 mm
max DISS with torsion =14.461 mm

VI. CONCLUSION

1) 8 noded with three loaded ring foundation:-

a) In the analysis of 8 noded with three loaded ring foundation, the maximum value of bending moment (BM) with torsion is more than the without torsion.

b) The value of shear force diagram and displacement of with and without torsion is nearly equal.

c) The value of BM with torsion is two times greater than the without torsion.

2) 8 noded with five loaded ring foundation:-

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a) In the analysis of 8 noded with five loaded ring foundation the maximum value of bending moment (BM) with torsion and without torsion is nearly equal.

b) The value of shear force diagram and displacement of with and without torsion is nearly equal.

3) Effect of twisting moment (torsion) for ring foundation is a decrease by increasing point loads.

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