CHAPTER 10

ANALYTICAL WORK – ‘3D’ FRAME

10.1 GENERAL

To validate the experimental results, non-linear finite element analysis has been carried out using ANSYS-10 software for ‘3D’ frame (1) and (2). A comparative study was made between experimental and analytical values.

The following are the detailed input parameters adopted for the analytical work

1 **Drawing tools**: Key points, lines, areas, volume area generate, volume generate, volume glue, line glue.

2 **Material properties**:
   (i) **Reinforcement Steel**
   - Youngs modulus: 21610 kg/mm²
   - Density: 7850 kg/m³
   - Poisson ratio: 0.3

   (ii) **Concrete**
   - Youngs modulus: 2308 kg/mm²
   - Density: 2400 kg/m³
   - Poisson ratio: 0.17

   (iii) **Brick Masonry**
   - Youngs modulus: 339.7 kg/mm²
   - Density: 2000 kg/m³
   - Poisson ratio: 0.25

3 **Element type**:
   (i) **Reinforcement Steel**
   - Link 8 spar

   (ii) **Concrete**
   - Solid 65 (10 node)

   (iii) **Brick**
   - Solid 45 (8 node)
4 Meshing: Solid used for hexa mesh using mape mesh (brick mesh)

5 Boundary conditions: Frame bottom concrete pillars fully arrested at all degrees of freedom (ux, uy, uz)

6 Applying loads:
- Top beam: Apply the 5 kN to 105 kN
- Bottom beam: Apply the 5 kN to 105 kN
- Top beam: Apply the 5 kN to 195 kN
- Bottom beam: Apply the 5 kN to 195 kN

10.2 ANALYTICAL WORK – ANSYS 10 ‘3D’ FRAME

RC frames (1) and (2) were modeled in the ANSYS-10 software as shown in Figure 10.1 (a) for frame (1) and Figure 10.1 (b) for frame (2).

![Figure 10.1(a) The R.C frame modeled in ANSYS –10 for frame (1)](image)

**Model Frame**  **Model for steel link**  **Meshing and boundary conditions**
After every push pull loading, deformations were recorded. Also stress distribution were studied. The deformed shape of the software model for frame (1) for various cycles are shown in Figure 10.2 (a) and for ultimate load is shown in Figure 10.2(b).
LOAD 10 KN,
DEFLECTION – 1.75

LOAD – 10 KN,
DEFLECTION – 1.64

LOAD 15 KN,
DEFLECTION – 2.66

LOAD – 15 KN,
DEFLECTION – 2.56

LOAD 20 KN,
DEFLECTION – 3.69

LOAD – 20 KN,
DEFLECTION – 3.48

Figure 10.2(a) (Continued)
LOAD 25KN,
DEFLECTION – 4.82

LOAD 25KN,
DEFLECTION – 4.61

LOAD 30KN,
DEFLECTION – 6.05

LOAD 30KN,
DEFLECTION – 5.84

LOAD 35KN,
DEFLECTION – 6.76

LOAD 35KN,
DEFLECTION – 6.56

Figure 10.2(a) (Continued)
Figure 10.2(a) (Continued)
Figure 10.2(a) (Continued)
LOAD 70 KN, DEFLECTION – 16.50

LOAD – 70 KN, DEFLECTION – 15.99

LOAD 75 KN, DEFLECTION – 19.06

LOAD – 75 KN, DEFLECTION – 18.04

LOAD 80 KN, DEFLECTION – 21.72

LOAD – 80 KN, DEFLECTION – 20.70

Figure 10.2(a) (Continued)
Figure 10.2(a) (Continued)
LOAD 100KN, DEFLECTION – 43.55

LOAD – 100 KN, DEFLECTION – 41.50

Figure 10.2(a) (Continued)

LOAD – 105 KN, DEFLECTION – 59.43

Figure 10.2(b) Ultimate Deformed shape of the software model for Frame(1)
The deformed shape of the software model for frame (2) for various cycles are shown in Figure 10.3(a) and for ultimate load is shown in Figure 10.3(b)

**Figure 10.3(a) Deformed shape of the software model for frame (2)**
Figure 10.3(a) (Continued)
Figure 10.3(a) (Continued)
Figure 10.3(a) (Continued)
LOAD 60 KN, DEFLECTION – 8.29

LOAD 65KN, DEFLECTION – 10.36

LOAD 70 KN, DEFLECTION – 12.43

LOAD – 60 KN, DEFLECTION – 7.96

LOAD – 65 KN, DEFLECTION – 9.83

LOAD – 70KN, DEFLECTION – 11.89

Figure 10.3(a) (Continued)
LOAD 75 KN,  
DEFLECTION – 14.50

LOAD – 75KN,  
DEFLEXION – 13.96

LOAD 80 KN,  
DEFLEXION – 16.58

LOAD – 80 KN,  
DEFLEXION – 16.03

LOAD 85 KN,  
DEFLEXION – 18.65

LOAD – 85KN,  
DEFLEXION – 18.10

Figure 10.3(a) (Continued)
Figure 10.3(a) (Continued)
LOAD 105 KN, DEFLECTION – 27.97
LOAD 105 KN, DEFLECTION – 27.30
LOAD 110 KN, DEFLECTION – 30.04
LOAD 110 KN, DEFLECTION – 29.17
LOAD 115 KN, DEFLECTION – 33.15
LOAD 115 KN, DEFLECTION – 32.06

Figure 10.3(a) (Continued)
LOAD 120KN, DEFLECTION – 36.26
LOAD – 120KN, DEFLECTION – 35.16
LOAD 125KN, DEFLECTION – 37.30
LOAD – 125KN, DEFLECTION – 35.99
LOAD 130 KN, DEFLECTION – 38.33
LOAD – 130KN, DEFLECTION – 37.03

Figure 10.3(a) (Continued)
Figure 10.3(a) (Continued)
LOAD 150KN, DEFLECTION – 46.62
LOAD 155KN, DEFLECTION – 48.69
LOAD 160 KN, DEFLECTION – 50.76
LOAD – 150KN, DEFLECTION – 46.68
LOAD – 155KN, DEFLECTION – 46.75
LOAD – 160KN, DEFLECTION – 48.61

Figure 10.3(a) (Continued)
Figure 10.3(a) (Continued)
LOAD 180 KN, DEFLECTION – 60.09

LOAD – 180KN, DEFLECTION – 57.30

LOAD 185 KN, DEFLECTION – 63.20

LOAD – 185 KN, DEFLECTION – 60.09

LOAD 190KN, DEFLECTION – 66.30

LOAD – 190KN, DEFLECTION – 63.19

Figure 10.3(a) (Continued)
LOAD – 195 KN, DEFLECTION – 70.45

Figure 10.3(b) Ultimate Deformed shape of the software model for frame (2)

The results obtained from the analytical study for frame (1) and (2) are compared with the experimental values and are tabulated (Table 10.1). The results obtained from the analytical study by ANSYS-10 for frames (1) and (2) are compared with experimental results and the variation is found to be in the range of 6-15% in final stages. In the analytical study, it is noticed that there is a sudden increase in deflection after the base shear of 45 kN (nearly equal to experimental value of 40 kN) for frame (1) and the base shear of 80 kN (nearly equal to experimental value of 80 kN) for Frame (2). This proves the initiation of the captive column behaviour adjacent to the gap region in frame (1) and the failure takes place earlier, whereas in frame (2) the failure of the frame delayed.

Load Vs deflection results from experimental values and analytical work are plotted and compared in graph form and in bar form for frame (1) and (2) (Figure 10.4).
Table 10.1 Comparison of base shear Vs top storey deflection

<table>
<thead>
<tr>
<th>Load Cycle No.</th>
<th>Base Shear in kN</th>
<th>Frame (1) Deflection in mm</th>
<th>Frame (2) Deflection in mm</th>
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Figure 10.4  Comparison of base shear Vs top storey deflection for frame (1) and (2) with experimental and analytical