DEFLECTION STUDY OF RCC LOAD BEARING WALL AND SLAB

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INTRODUCTION

Introduction of the project

Low cost Residential housing by Delhi State Industrial & Infrastructure Development Corporation at Bawana, New Delhi.

- A G+3 building with RCC load bearing walls
- 484 dwellings
- One room set dwelling with attached toilets.
- Designed as RCC load bearing wall and slab structure.
- Constructed using flexible shuttering.
- Door opening in the common RCC wall was created after full construction.

Flexible shuttering method

- Fast
- Simple
- Cost-effective
- Gives a good quality work which requires minimum maintenance

RCC load bearing walls and slabs

- Monolithic casting of slab along with RC walls results in a box type structure.
- Strong in resisting horizontal forces due to wind or earthquake.
- In view of large depth of shear walls, the resulting stresses due to bending moment and vertical loads are smaller.
- In many cases, concrete alone is capable of resisting these forces.

OBJECTIVE OF THE WORK

- LOAD TEST ON THE EXISTING BUILDING AT BAWANA
- NUMERICAL ANALYSIS
- COMPARISION OF THE RESULTS

Need for the study

- To study the behaviour of RCC load bearing wall and slab system
- To study the effect of door opening.
- To study the deflections in the slab when it is casted with M15 grade of concrete.

METHODOLOGY

CALCULATIONS FOR ALLOWABLE DEFLECTION

- **CALCULATION FOR ALLOWABLE DEFLECTION:**
- As per IS : 456 -2000 article 17.6 it is mentioned that the structure should be tested for full dead load and 1.25 times the live load. Dead weight includes weight of finishes and partition walls if any. The deflections are then compared with the maximum allowable deflection which is as given below. As per the code

Allowable deflection $=40x\ L^2/\ D$

Where L = effective span in meters

And D= overall depth of slab in mm.

- **For shorter span**

  Where, L= 3.6m and D=100mm

  Allowable deflection =40x L^2/ D

  =40x 3.6^2/100=5.18mm

- **For longer span**

  Where, L= 4 m and D = 100mm

  Allowable deflection =40x L^2/ D

  =40x 4^2/100 =6.4mm

- Adopting the least of the above two values i.e. 5.18mm

load test at site

- Load equal to 1.25 times the live load was applied in addition to the dead weight.
- Deflections at different points of slab were observed
- Observed deflections were compared with the allowable deflections as per IS:456-2000

The grids were marked over the floor and the roof with the help of colour.

With the help of drilling machine hooks were inserted in the roof , walls , across the door opening and top of the door opening.

The wires were tied at a height of five feets from the floor and plumb bobs were hanged from the roof.

Threads of the plumb bobs are marked at the point where it crosses the wires.

Live load was applied in the form of sand bags

- The load was kept for 24 hrs. and final reading was noted down. Actual deflection is compared with allowable deflection .

- Unloading of the load was done and the readings for recovery was taken after 48 hrs.

LOAD TEST RESULTS

- The deflections obtained by the field test at different points were tabulated and expressed in the graphical form.
- The deflections along the grids were also plotted.

NUMERICAL ANALYSIS

The Residential building was analysed by using the STAADPRO.V8i because it is a :-

- Leading structural analysis and design software.
- Design supports over 70 international codes and over 20 U.S. codes in seven languages.
- User friendly, faster, compatible, results are reliable and is extensively used everywhere.

STAAD Modelling of the housing

- STAAD modeling of the housing was done with the graphical aid.
- Walls and slabs were created as elements by defining as plate elements with a thickness of 100 mm.
- The support condition was generated as fixed.
- Load was applied as self weight of the slab,dead weight of the finishes and the live load as per IS: 875(part 2).
- A combination of loads is also applied.

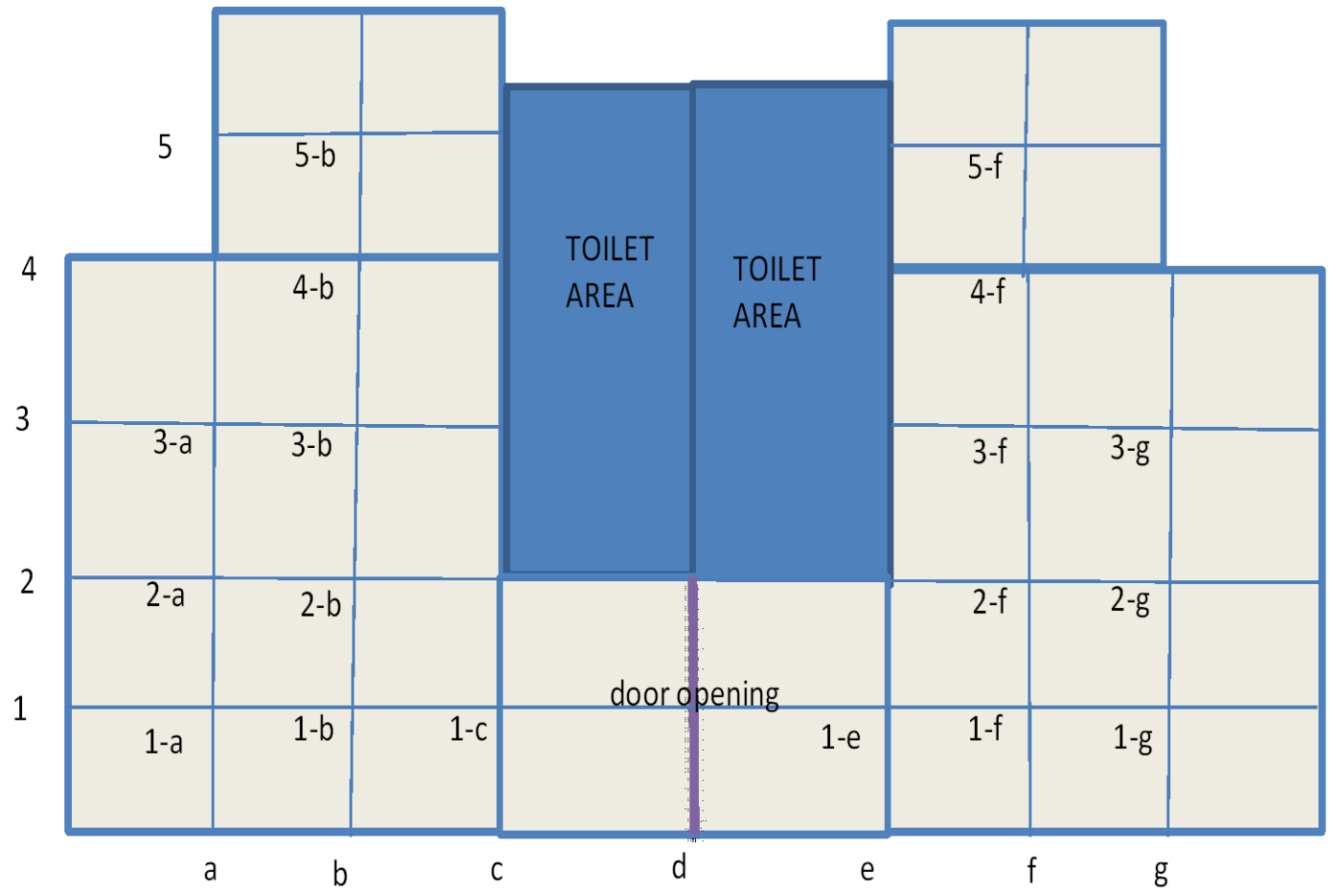
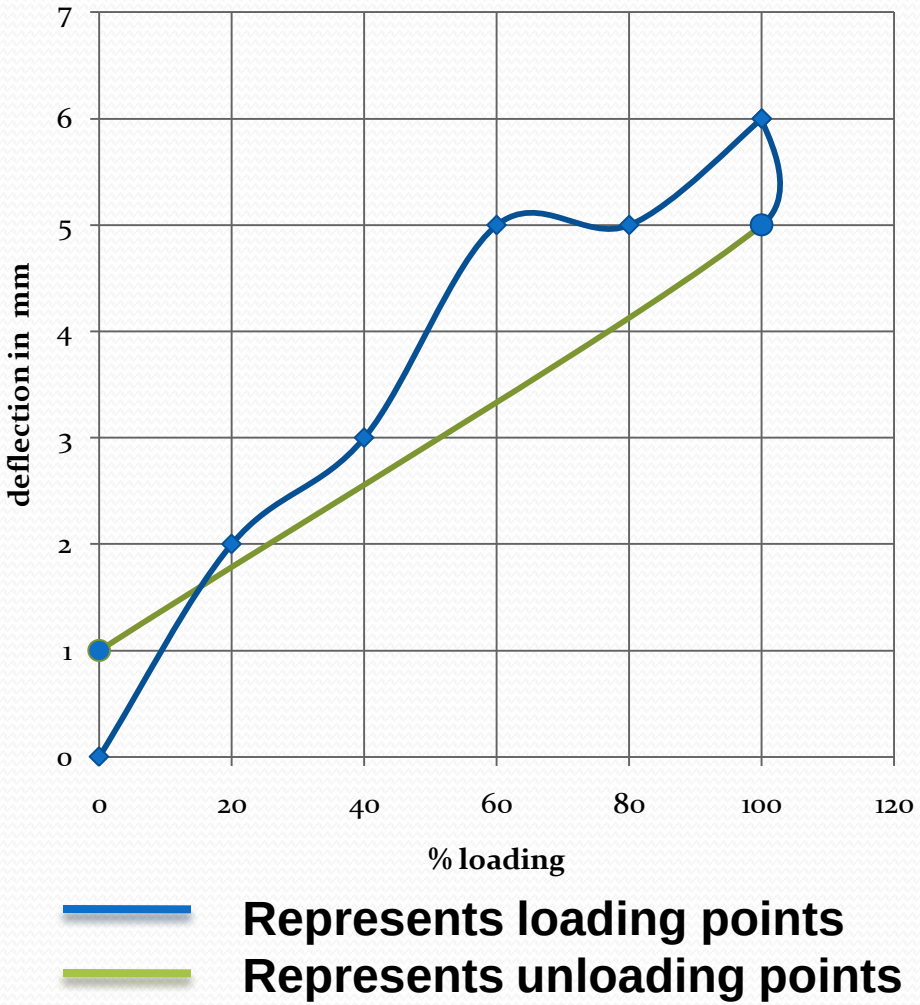


Figure Showing plan of two flats where the load test was performed

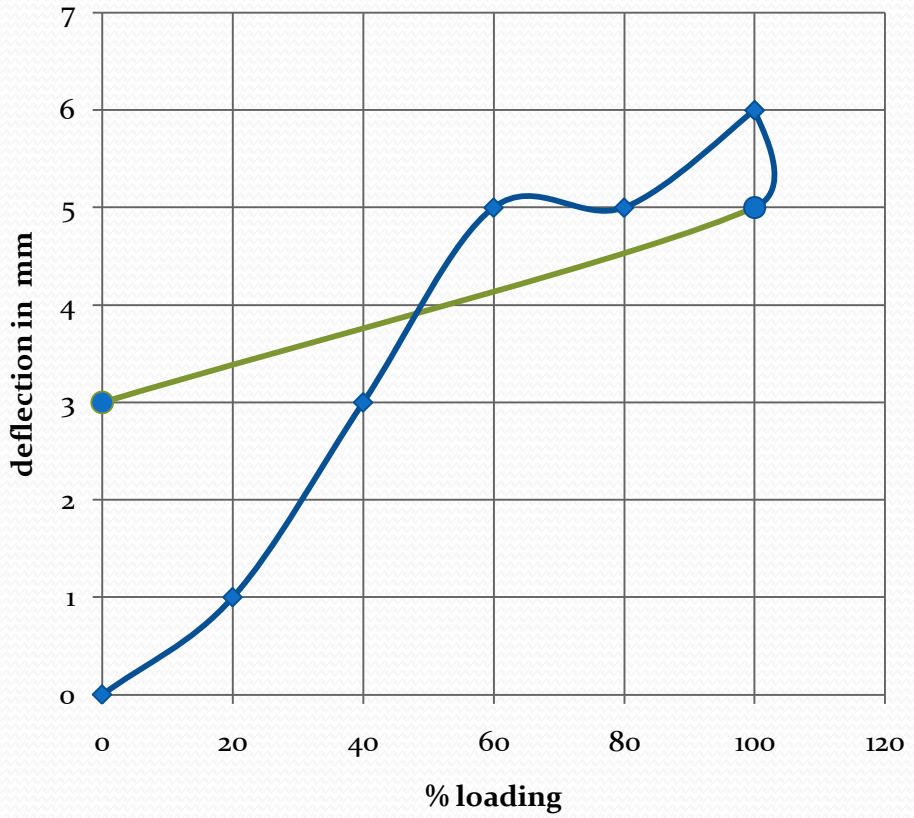
Deflections at point 1-a

loading	Time in hrs.	Deflection in mm
0	0	0
20%	1	2
40%	2	3
60%	3	5
80%	4	5
100%	5	6
100%	6	6
100%	29	5
0%	53	1
0%	72	



Deflections at point 2-a

loading	Time in hrs.	Deflection in mm
0	0	0
20%	1	1
40%	2	3
60%	3	5
80%	4	5
100%	5	6
100%	6	6
100%	29	5
0%	53	3
0%	72	

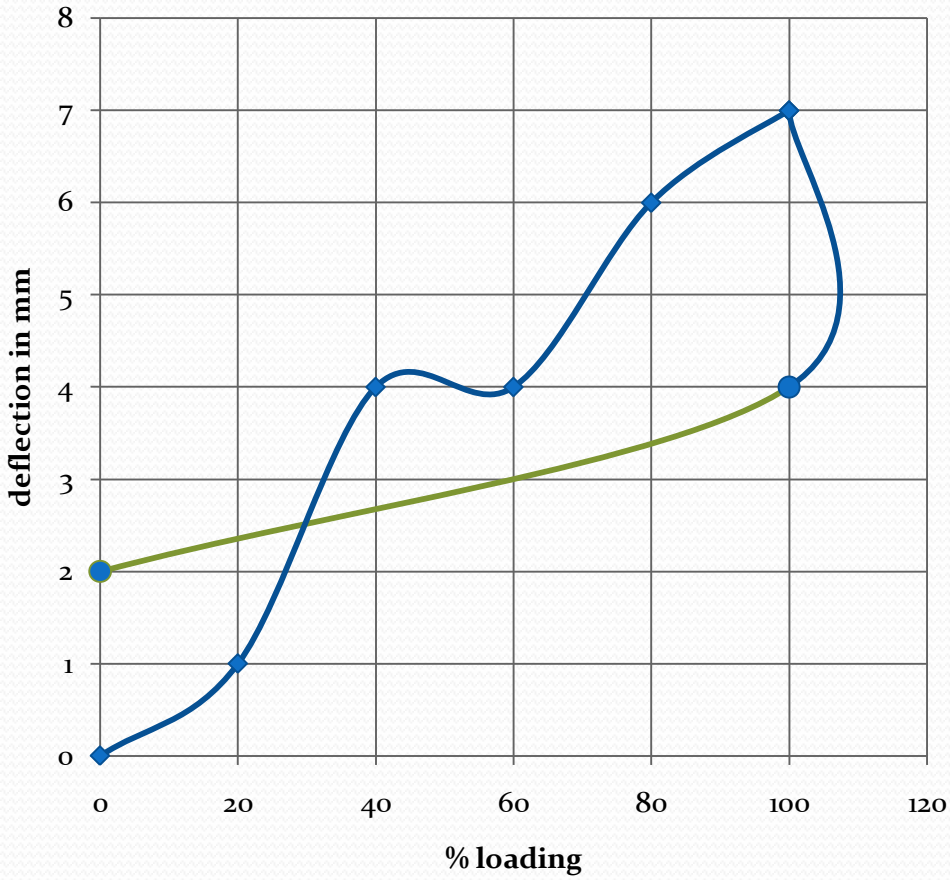


Represents loading points

Represents unloading points

Deflections at point 2-f

loading	Time in hrs.	Deflection in mm
0	0	0
20%	1	1
40%	2	4
60%	3	4
80%	4	6
100%	5	7
100%	6	7
100%	29	4
0%	53	2
0%	72	

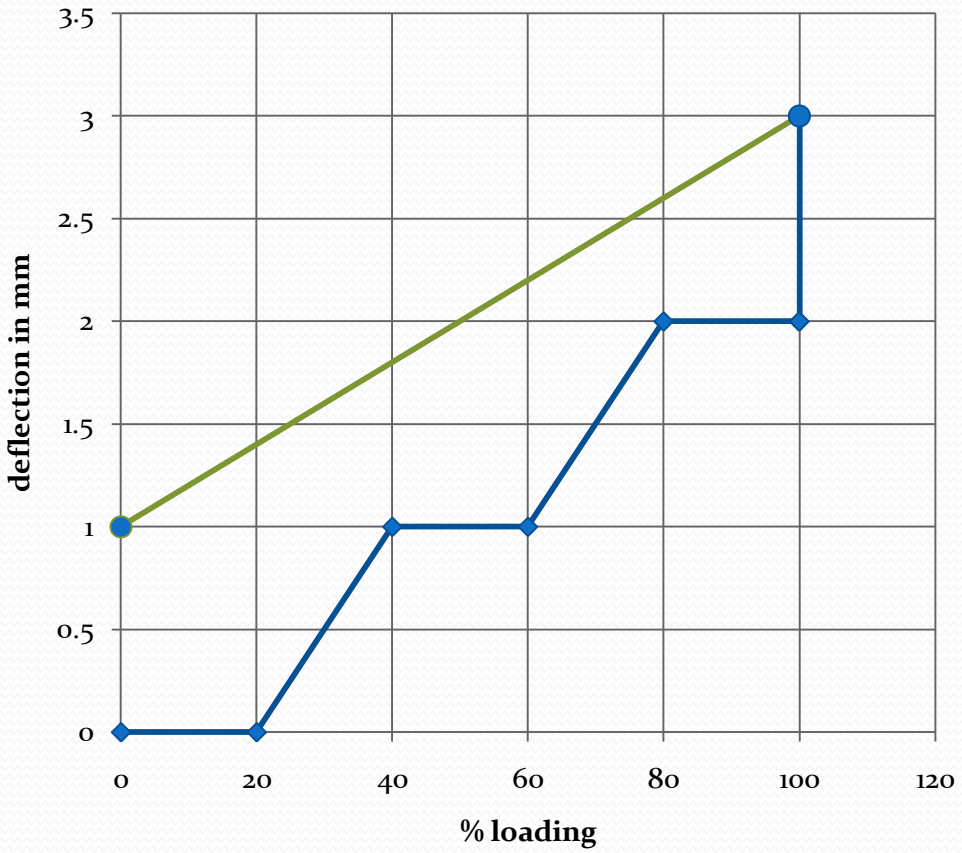


Represents loading points

Represents unloading points

Deflections at point 3-g

loading	Time in hrs.	Deflection in mm
0	0	0
20%	1	0
40%	2	1
60%	3	1
80%	4	2
100%	5	2
100%	6	2
100%	29	3
0%	53	1
0%	72	



Represents loading points

Represents unloading points

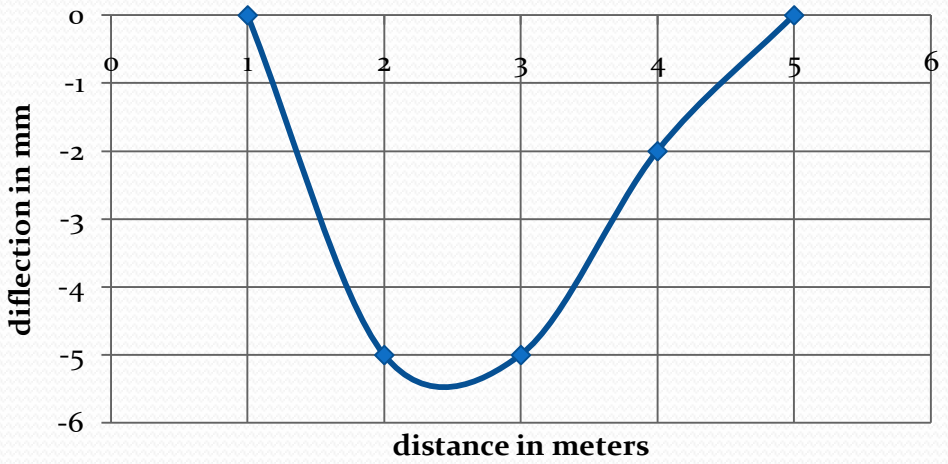
Similarily , observed deflection for all points were plotted

Consolidated data of total deflection (Field test)

Grid no.	initial reading	final reading	total deflection in mm	allowable deflection in mm	Remarks
Grid 1-a	1485	1480	5	5.18	safe
Grid 2-a	1460	1455	5	5.18	safe
Grid 3-a	1480	1476	4	5.18	safe
Grid 1-b	1460	1455	5	5.18	safe
Grid 2-b	1465	1462	3	5.18	safe
Grid 3-b	1463	1461	2	5.18	safe
Grid 4-b	1466	1465	1	5.18	safe
Grid 5-b	1471	1469	2	5.18	safe
Grid 1-c	109	107	2	5.18	safe
Grid 1-e	117	113	4	5.18	safe
Grid 1-f	1466	1465	1	5.18	safe
Grid 2-f	1464	1460	4	5.18	safe
Grid 3-f	1455	1453	2	5.18	safe
Grid 4-f	1460	1459	1	5.18	safe
Grid 5-f	1455	1450	5	5.18	safe
Grid 1-g	1480	1477	3	5.18	safe
Grid 2-g	1464	1460	4	5.18	safe
Grid 3-g	1447	1444	3	5.18	safe

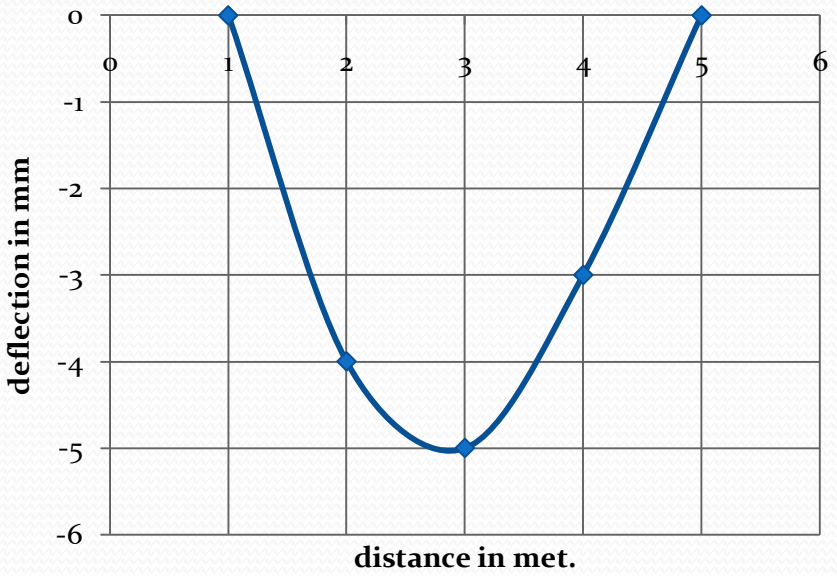
DEFLECTIONS ALONG GRID 1(ROOM 1)

Distance in met.	Deflection in mm
0	0
1	5
2	5
3	2
4	0



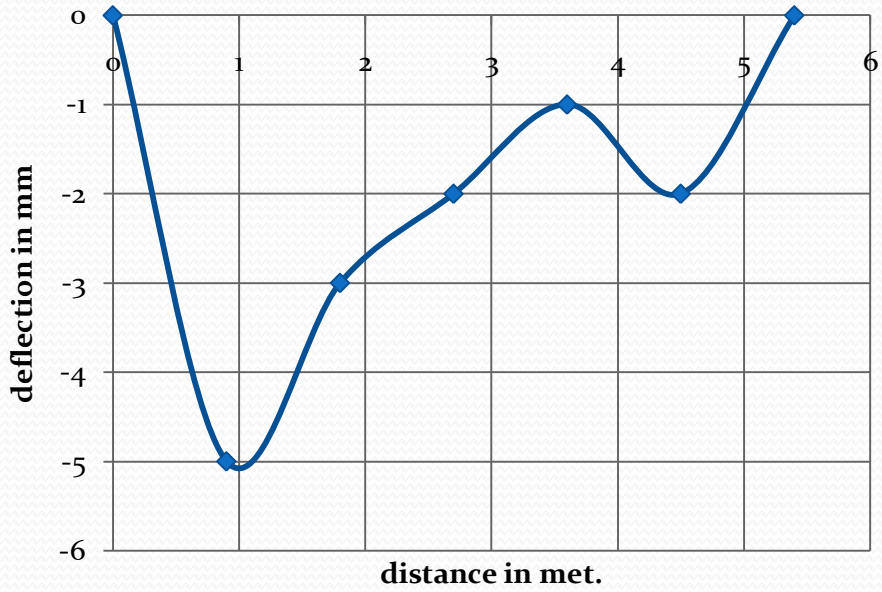
DEFLECTIONS ALONG GRID 1(ROOM 2)

Distance in met.	Deflection in mm
0	0
1	4
2	5
3	3
4	0



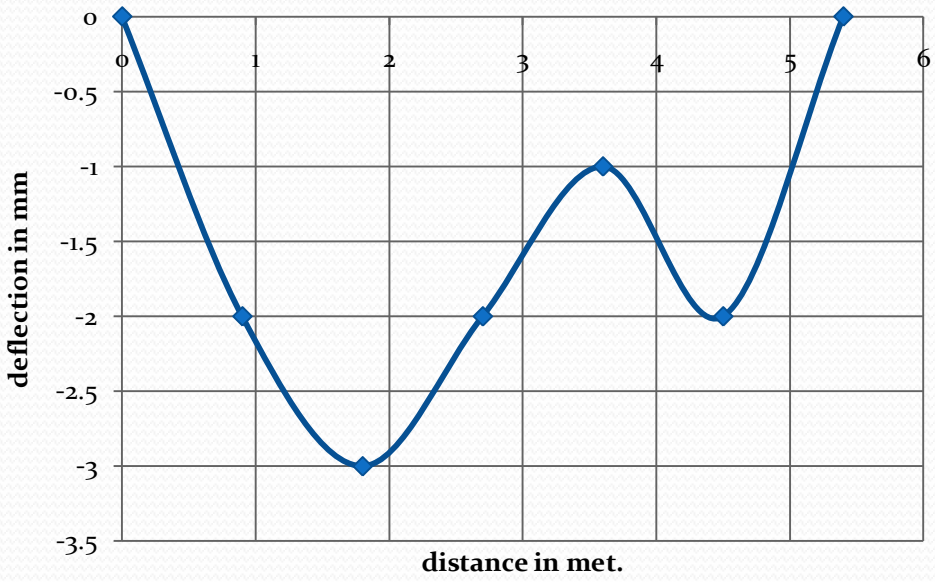
DEFLECTIONS ALONG GRID B(ROOM 1)

Distance in met.	Deflection in mm
0	0
0.9	5
1.8	3
2.7	2
3.6	1
4.5	2
5.4	0



DEFLECTIONS ALONG GRID F (ROOM 2)

Distance in met.	Deflection in mm
0	0
0.9	2
1.8	3
2.7	2
3.6	1
4.5	2
5.4	0



CONCLSIONS OF FIELD TEST

- Maximum deflection observed was within the permissible limits as per IS:456
- After unloading deformations were recovered partially.
- A part of deformation was not recovered and that may be called plastic deformation.
- In some of the points of the slab the plastic deformation is about 3mm,which is about 50 percent of the total deflection of the slab, it may be human error in recording the readings for those particular points.

NUMERICAL ANALYSIS RESULTS

The housing was modeled using the STAADPRO and the results obtained are studied and discussed in the following report. The results of the node displacements along the different grids are presented in the form of graph.

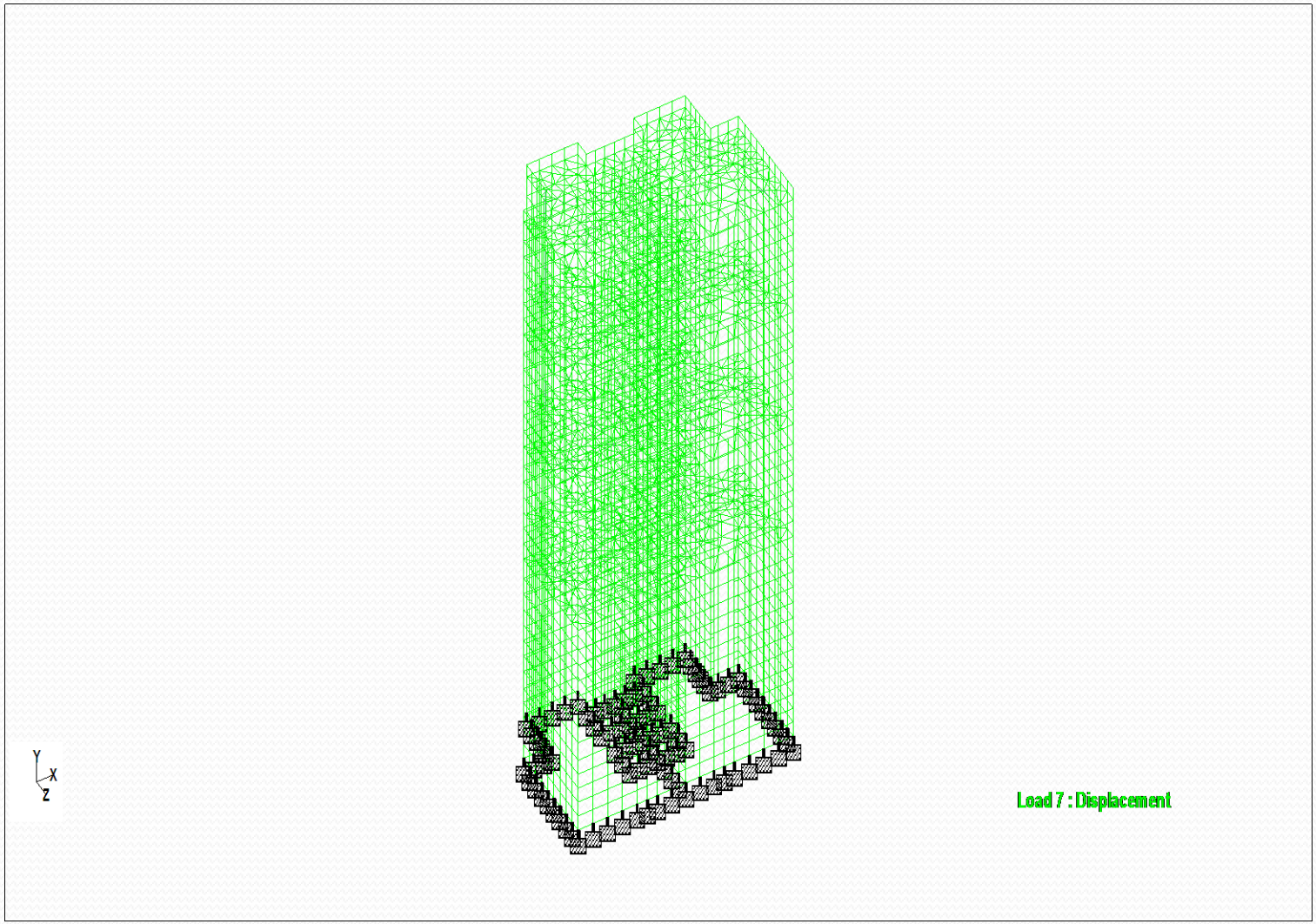
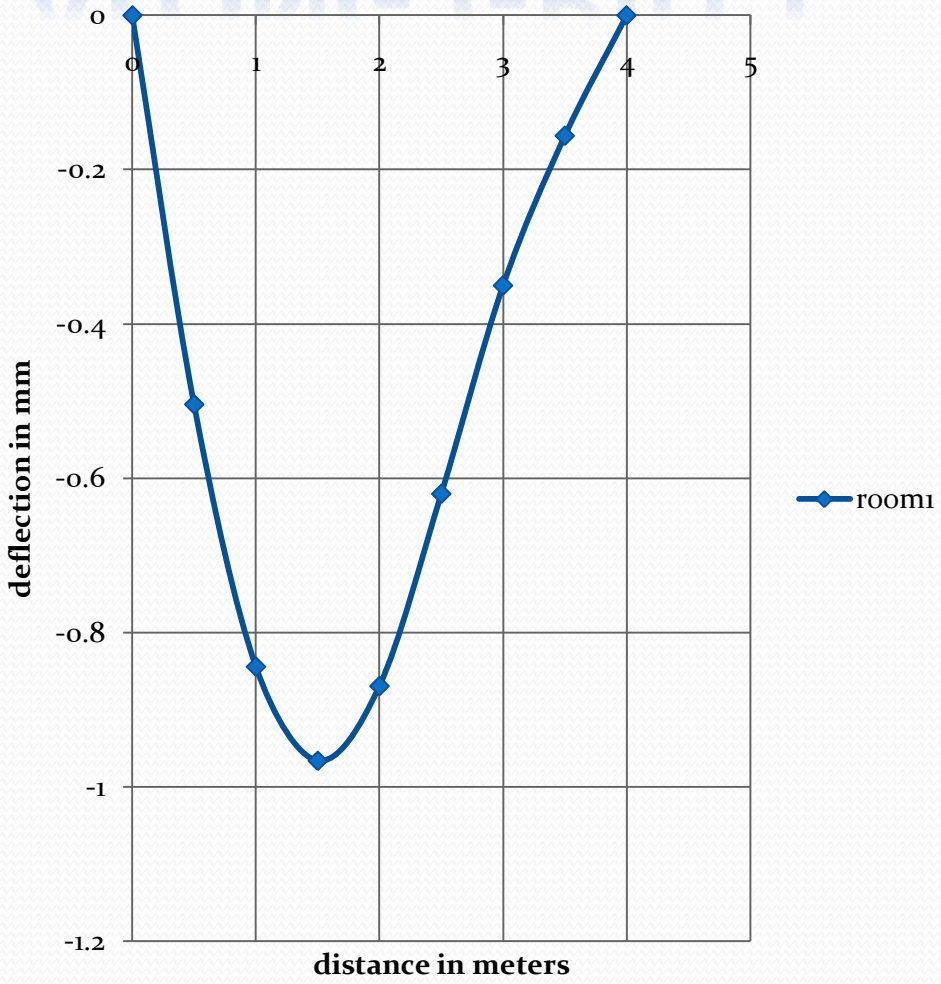


Fig.30 Showing STAAD model of the building

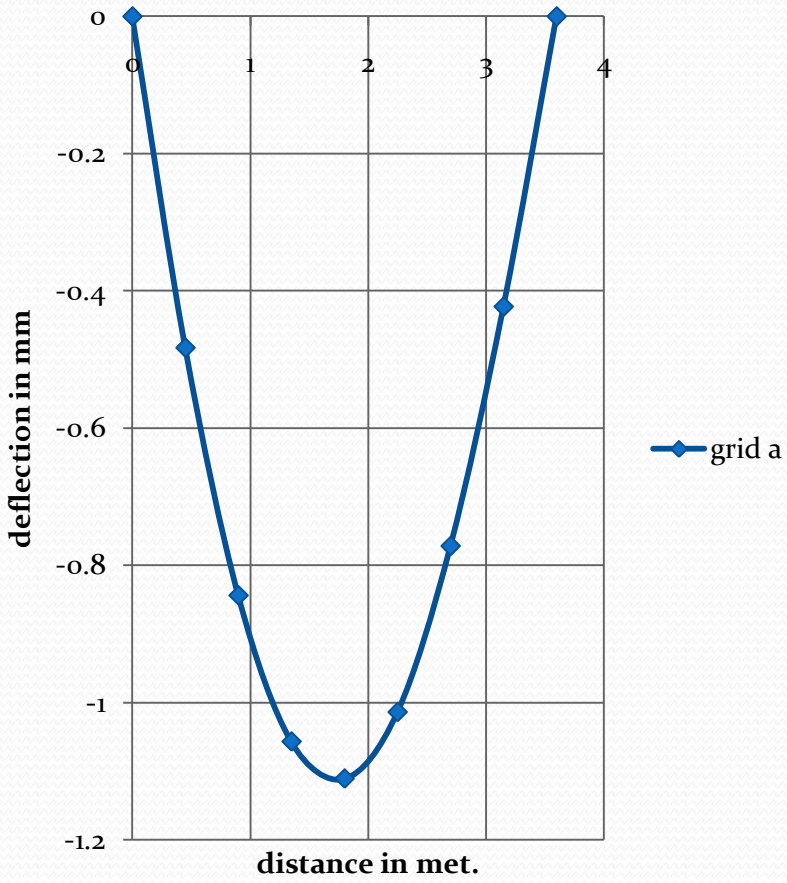
DEFLECTIONS ALONG GRID 1

Distance in met.	Deflection in mm,room1
0	0
0.5	-0.504
1	-0.844
1.5	-0.966
2	-0.869
2.5	-0.62
3	-0.35
3.5	-0.156
4	0



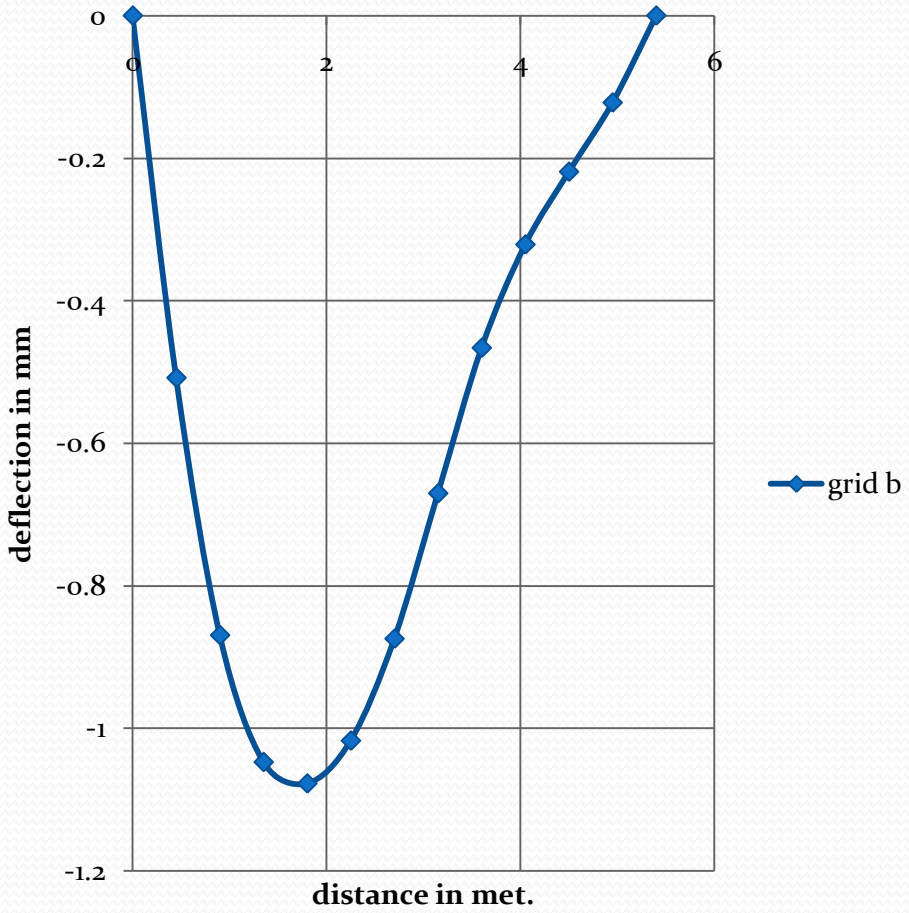
Deflections along grid a

Distance in met.	Deflection in mm,grid a
0	0
0.45	-0.483
0.9	-0.844
1.35	-1.057
1.8	-1.111
2.25	-1.014
2.7	-0.772
3.15	-0.423
3.6	0



Deflections along grid b

Distance in met.	Deflection in mm,grid b
0	0
0.45	-0.508
0.9	-0.869
1.35	-1.047
1.8	-1.077
2.25	-1.017
2.7	-0.874
3.15	-0.67
3.6	-0.466
4.05	-0.321
4.5	-0.219
4.95	-0.122
5.4	0

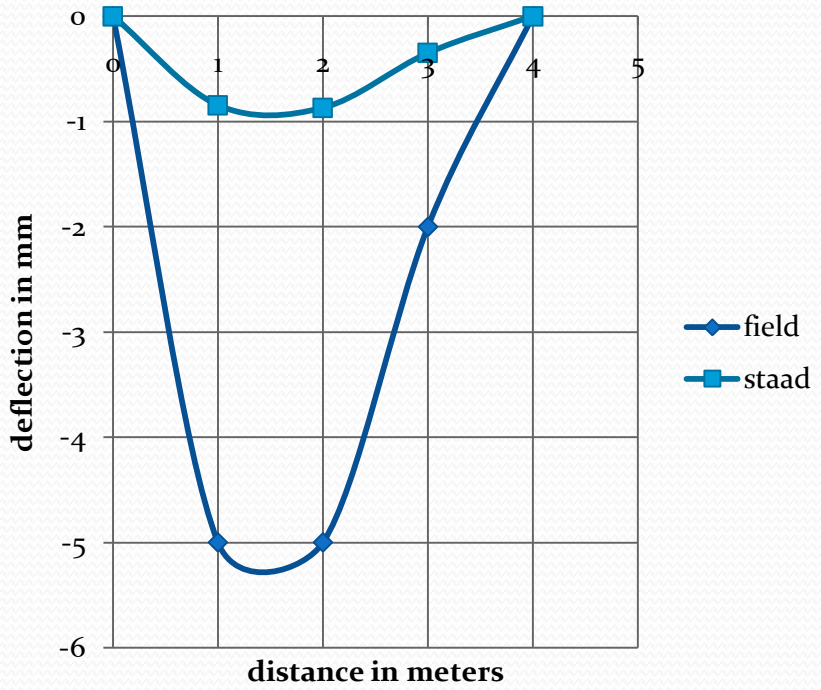


COMPARISION OF THE EXPERIMENTAL AND NUMERICAL METHOD OF LOAD TEST.

The results of the two methods were studied, compared and discussed ahead. The comparative results are plotted graphically to study the difference ,with deflections on vertical axis and distance from the origin on the horizontal axis.

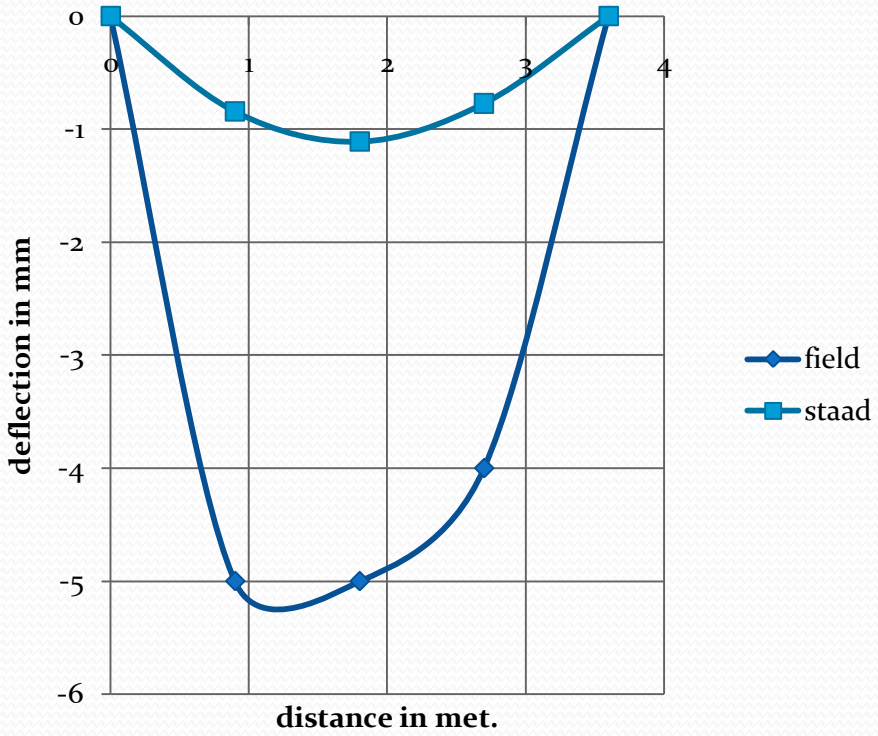
Deflections along grid 1

Distance in met.	Deflection as per field test,mm	Deflection as per Staad analysis, mm
0	0	0
1	-5	-0.844
2	-5	-0.869
3	-2	-0.35
4	0	0



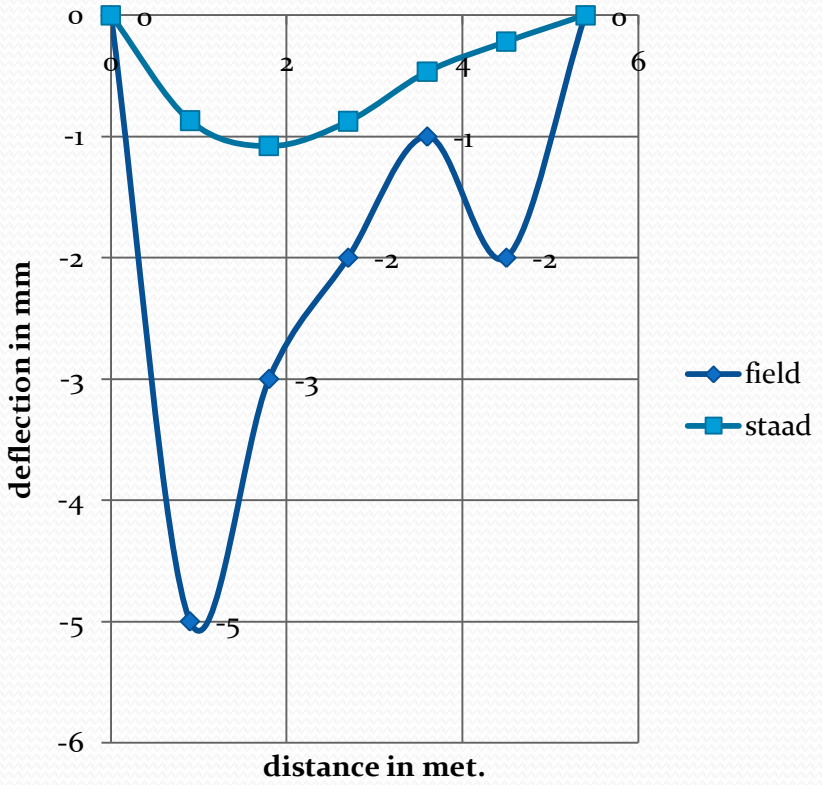
Deflections along grid a

Distance in met.	Deflection as per field test,mm	Deflection as per Staad analysis,mm
0	0	0
0.9	-5	-0.844
1.8	-5	-1.111
2.7	-4	-0.772
3.6	0	0



Deflections along grid b

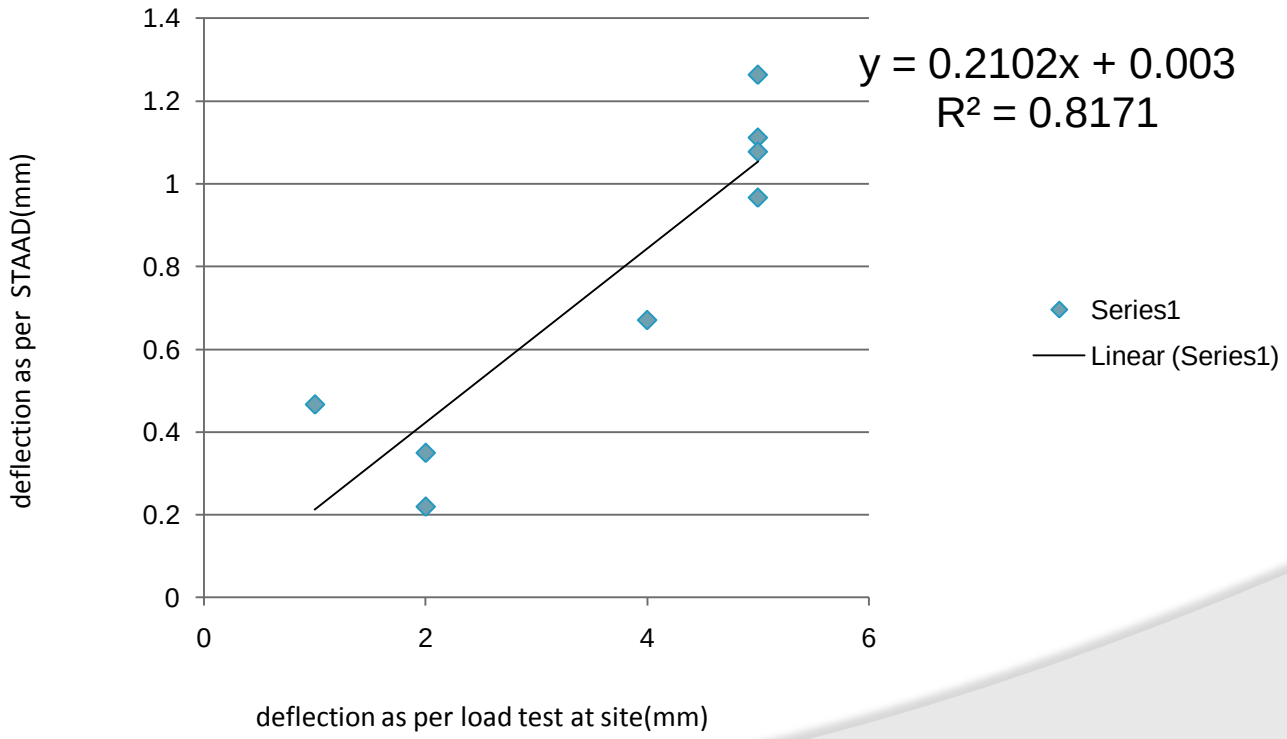
Distance in met.	Deflection in mm,field test	Deflection in mm, Staad results
0	0	0
0.9	-5	-0.869
1.8	-3	-1.077
2.7	-2	-0.874
3.6	-1	-0.466
4.5	-2	-0.219
5.4	0	0



Consolidated Deflections along grids

Grid marking	Deflection in mm (field test)	Deflection in mm (staad results)
1	5	0.966
2	5	1.263
3	4	0.67
4	1	0.466
5	2	0.219
a	5	1.111
b	5	1.077
c	2	0.349

Finding a compatible equation between the two tests



CONCLUSIONS

FIELD TEST

The deflections in the slab were in the range of

1 mm to 5 mm and were within the limits as mentioned in IS:456.the rebound of the slab was also noticed and it was upto 3 mm.

NUMERICAL ANALYSIS

The deflections in the slab ranges from 1 mm to 1.3mm in both the cases. This implies that the opening in the wall is not affecting the slab .

COMPARISION

There is a considerable difference in the deflections obtained experimentally and numerically.The maximum deflection found experimentally is 5mm while it is 1.2mm in the case of numerical analysis The reason may be:

- The software is adopting the ideal case of the quality of material and the workmanship.
- Proper length of anchorage and development length may not have taken care thus resulting in higher deflections.

COMPATIBILITY EQUATION

$y=0.210x+0.003$

here , y = deflection by staad results

and x = deflections by field test

$R^2 = 0.817$

This is a linear equation with a reliability of 81.7 percent as the correlation factor(R^2) is 0.817. The validity of this equation is subject to the conditions adopted during the load test.

THANKS