

# Seismic Impact of Re-entrant Corner with Opening in Diaphragm on RC Building

Md Faisal Zia, Rajiv Banerjee

**Abstract:** The most important cause of damage of RC buildings during earthquake is the irregular building configuration. An RC building which are unsymmetrical and has lack of continuity in geometry, mass or load resisting elements is called as irregular buildings. This obstructs the flow of inertia forces and cause lots of damage to buildings. There are many studies carried out irregular buildings in seismic zones, but still more research is needed in this field. Therefore, this study is about the seismic response of reinforced concrete structures having combination of two plan irregularities, re-entrant corner and diaphragm discontinuity buildings. Study is performed combining this two plan irregularity criteria and analyzing the results in seismic zone 4 and 5. For this 1 is regular building, 3 re-entrant corner buildings with three variations in A/L ratio, three buildings with opening in diaphragm with three varying percentage of opening. 9 structures are made combining these buildings with the combination of two irregularities. Structures are analyzed in etas software. Parameters such as story displacement, story drift, base shear, overturning moments are determined and compared with regular buildings.

**Keywords:** Re-entrant corner, diaphragm discontinuity response spectrum, displacement, drift, base shear, overturning moment.

## I. INTRODUCTION

When horizontal forces act at the base of the structure an inertia force are generated. These inertia forces are directly proportional to mass of the building. These inertia forces develop at the floor level as most of the building mass is present at the floor level. These inertia forces are transferred to the walls or the columns by slabs and then to the foundation which disperses them safely to ground. The flow of inertia force should be smooth and continuous through the building. As inertia forces accumulate downwards from the top of the building, the lower story experience higher forces than upper story. Therefore, the lower story should be designed stronger than the upper. The buildings having unsymmetrical geometrical configuration and discontinuity in diaphragm are more unstable in seismic affect than regular one.

Many researchers carried out research work on irregular building design ins seismic zones. Komal R. Bele1, S. B. Borghate (2015) focused on buildings with large projections of Re-entrant corners results in torsion. He took four models one regular and other 3 with varying projections. The conclusion of this paper was base shear decreases from Model

R to L5 (decreases with increase in projection). He also concluded that as projection of increases there are more coupling of modes. Result obtained shows that forces in column (common in all building) shows that the variation of P much higher with increase in projection. Rakesh Sakale, R K Arora and Jitendra Chouhan (2014) studied seismic behaviour of horizontally irregular buildings with regular building. L-shape, T-shape, C-shape and regular shape buildings of equal height are taken and lateral displacement and story drift are derived after analysis. Results were compared and studied. Analysis is performed in staad pro. For seismic zone II, III, IV, and V. Results were such that from drift point of view for zone II TO IV all frames are within permissible limit and there is no need to provide shear wall. Only with the building with plan C exceeds the permissible limit and may require shear wall. For displacement point of view, all buildings are within permissible limit only for zone II. In zone III and above regular plan building slightly exceeds the permissible limit but other requires shear wall to control the limit. Babita Elizabeth baby and shreeja s (2015) studied slab discontinuity at different position that is at the centre, at corners, and at periphery. Pushover analysis are performed in etabs software. Results were that the axial forces, bending moment and story drift are more effectively resisted by the model having slab opening in periphery. So, the opening is more effective to be located at periphery. Shiva kumar hallale and H sharada bai (2016) took three building, one regular and another two with re-entrant corner building plan. Response spectrum method is used for analysing in etabs. Parameters such as eccentricity, maximum displacement and drift, base shear, max. story acceleration, time period, member force in beam and column. Results obtained were eccentricity, max displacements, max story, drift increases in both direction x and y with the increase in plan irregularities. Kazi Muhammed mustaqeem and md mansoor ahmad (2016) his research paper consists two types of configuration, one with opening in slabs and other re-entrant corner structure having varying percentage of irregularities. Analysis was performed for static analysis, dynamic analysis and push over analysis and parameters were displacement, drift, base shear and time period. The results were such that the magnitude of displacement is more in static method. Response spectrum showed more accurate results and can be better considered for seismic activity. Pushover analysis gives higher value as it is analyzed for extreme. More percentage of re-entrant corner max drift. Base shear is max. for regular model less for re-entrant models. As base shear of the building increases, more seismic forces will be attracted by the member. Subodh. S.Patil, Shrinivas. R.Survanshi (2016) focused on seismic response of regular multi-storey building with asymmetrical plan is checked and compared with regular multi-storey building.

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\* Correspondence Author

**Md Faisal Zia\***, P.G student, department of civil engineering, Integral University, Lucknow, India. Email: faisalzia001@gmail.com

**Rajiv Banerjee**, Associate professor, department of civil engineering, Integral University, Lucknow, India. Email: rajeev2009banerjee@gmail.com

## Seismic Impact of Re-entrant Corner with Opening in Diaphragm on RC Building

A building with g+20 and g+22 building having plan asymmetry is modelled and analysed in finite element analysis stadd pro v8i. shear wall is provided at re-entrant corner in the buildings. Results of this paper as increase in height of L-shape building directly increase in relative displacement & stress at re-entrant corners. Increase in height of T-shape building directly increase in relative displacement and stress will be developed at re-entrant corner. T-shape building with shear wall and without shear wall after analysis shows uniform stress developed at re-entrant corners. In T-shape building re-entrant corners did not fail because of stresses carried by the shear wall. But without shear wall it will fail. Reena sahu and Ravi dwivedi (2017) studied about diaphragm discontinuity taking 5 structures. One as regular and other 4 as the increasing percentage in slab opening 0%, 4%, 16%, 24%, 36%. Response spectrum analysis using stadd pro. is done. Parameters like base shear, bending moment, story drift, shear force are obtained. Results shows that the increase in opening percentages, increases the story drift. 24% opening have less value of maximum shear force as compared to 16% opening. Akshay Nagpure, S. S. Sanghai (2018) studied RCC framed building structures which have been analyzed using ETABS software by linear time history analysis by changing flexibility of the floors and simultaneously when plan irregularities are provided. He took four plans- opening at the centre, opening at the corners, opening at the horizontal faces, opening at the vertical faces. Time history record of El Centro Earthquake has been provided to the software. Responses of all those structures has been plotted and discussed. An attempt is made in this paper to compare the responses of the structures when floor diaphragm flexibility is changed and simultaneously plan irregularities are provided. He concluded that floor Diaphragm Flexibility affects Base Shear of the Building, Column Forces, Beam Forces but doesn't show considerable difference in Time Period and Storey Drift. Sanjay Naik, Tushar S Shetty (2019) research paper involves the modelling and analysis of G+10 storied building of Regular shape plan, L-shape plan and C shape plan structure using ETABS 2016 software. The parameters such as displacement, drift, shear and overturning moment are compared and it was found that Rectangular shape is the best suited and L shape structure is the least desired shape for construction in seismic zone.

Research works has been done for various plan irregularities and vertical irregularities. Conclusion can be made after review of above literatures that unsymmetrical building shows more instability than regular one. The various parameters such as displacements, story drift, overturning moment shows large variations from regular building to plan irregular building and then to vertical irregular building. Shear wall provided is of great help in order to maintain the structural stability of the structure. Base isolation and seismic dampers can also be applied in or to reduce base shear, lateral displacement, story drift. Still very less work is carried out in the field of combinations of plan irregularity.

## II. THEORY

As per IS 1893 Part 1 irregularities of two types: paper in both email address.

1. Plan irregularities
2. Vertical irregularities

Re-entrant corners: inside corners of an asymmetrical building are subjected to stress concentration during earthquake motion. Thus, these corners are more prone to damage during earthquakes.

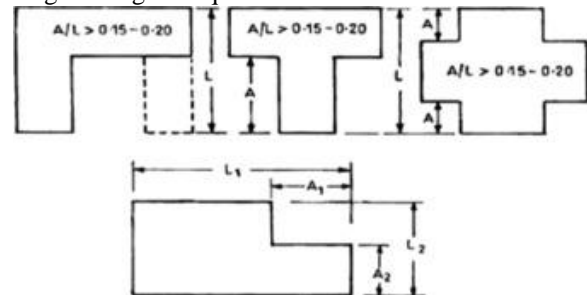
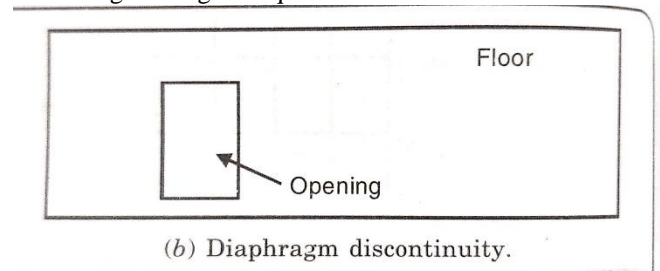


Fig. 1: Re-entrant corner

Diaphragm discontinuity: roof or floor acts as diaphragms (horizontal resisting elements). The diaphragm discontinuity is because of the cut-out or large openings. This causes reduction in the load carrying capacity of diaphragm and may cause damage during earthquake.



(b) Diaphragm discontinuity.

Fig. 2: Diaphragm discontinuity

## III. OBJECTIVE OF STUDY

To study the retaliation of plan irregular structures as per IS 1893 part 1 in seismic zones IV and V and collate with reaction of regular building model.

## IV. METHODOLOGY

- (A). Review of the existing literatures by different researchers.
- (B). G+14 story, 10 buildings are taken with 1 regular plan, 3 with varying re-entrant corner plan, 3 with varying opening in diaphragm, 3 with the combination of varying re-entrant corner and opening slab.
- (C). Modelling and analysis are done as per IS 1893 part 1 by response spectrum method in etabs software for zone IV and V.
- (D). Parameters such as base shear, max. story displacement, max. story drift, overturning moment are plotted in forms of tables and then graphs.
- (E) results are collated with regular building models.

## V. DETAILS OF THE BUILDING

For study purpose, the layout of the plan has 5 X 5 bays of equal length of 6m.

Building parameters are as follows –

- Type of building: SMRF
- Numbers of Storey: G+14
- Seismic zone: IV and V
- Floor height: 3m
- Grade of concrete: M35
- Grade of steel: Fe500
- Beam dimension: 400 x 700mm
- Column dimension: 450 x 800mm
- Slab depth: 150mm
- Dead load on floor: 0.52 KN/m<sup>2</sup>

Mortar screeding – 0.21 x 2 (IS 875 PART 1 table 2 page 31)

Clay floor tiles – 0.10 (IS 875 PART 1 table 2 page 30)

- Live load on floor: 2.5 KN/m<sup>2</sup> (IS 875 PART 2 table 1)
- Masonry load: 4.59 KN/m (outer wall)

3.519 KN/m (inner wall)

[AAC (Autoclaved Aerated Concrete Block) is used.]

(unit weight of AAC blocks – 6 KN/m<sup>3</sup>)

- Importance factor: 1
- Response reduction factor<sup>®</sup>: 5
- Site type: II
- % imposed load: 25%

## VI. MODELS.

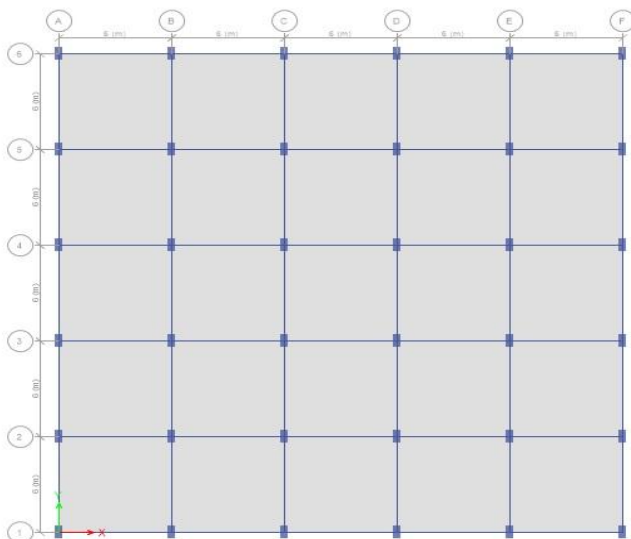


Fig. 3: MODEL R-REGULAR

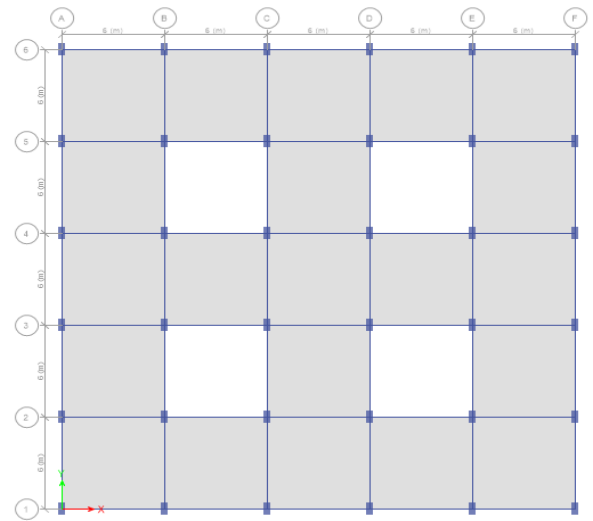


Fig. 4: MODEL D1 (16% OPENING)

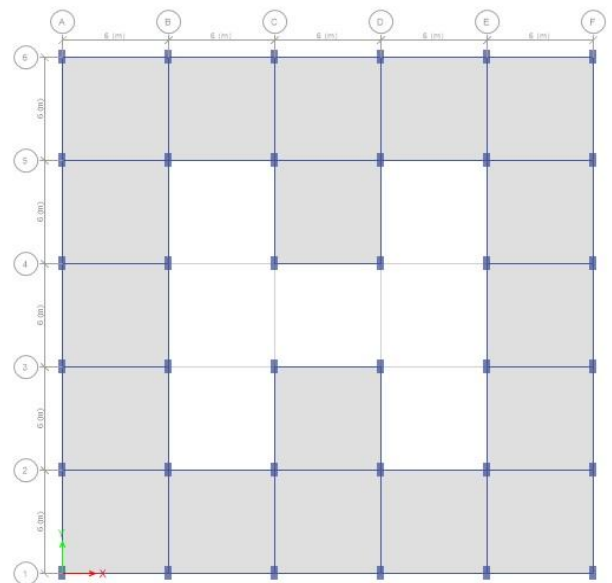


Fig. 5: MODEL D2 (28% OPENING)

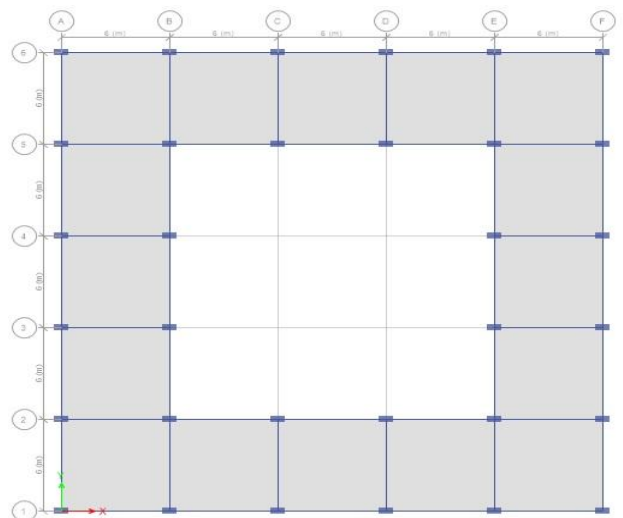
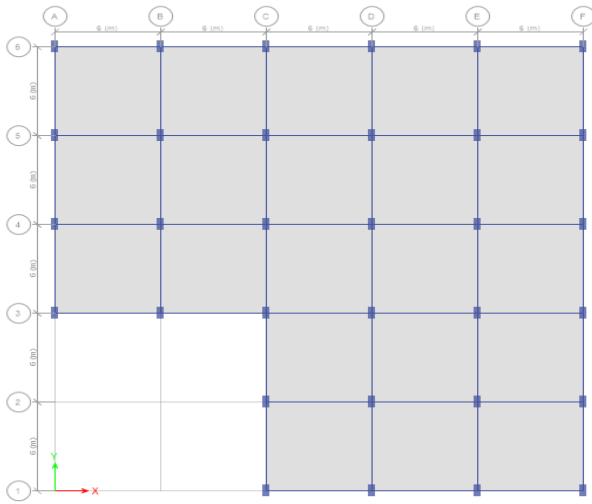
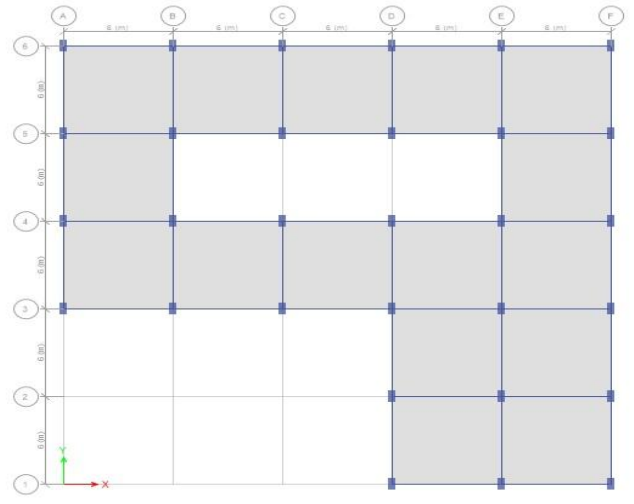


Fig. 6: MODEL D3 (36% OPENING)

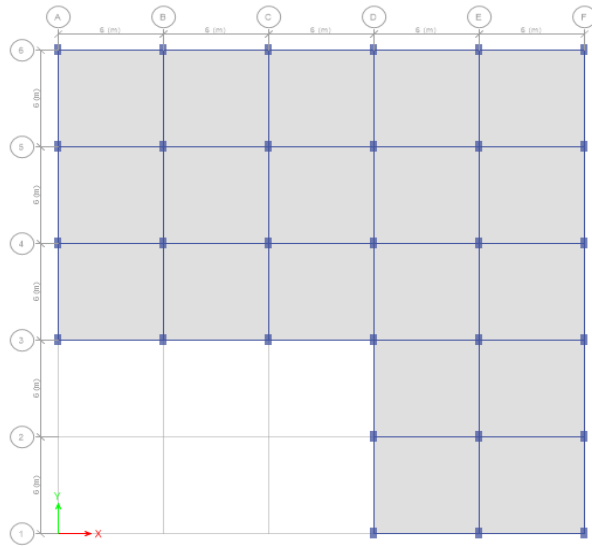
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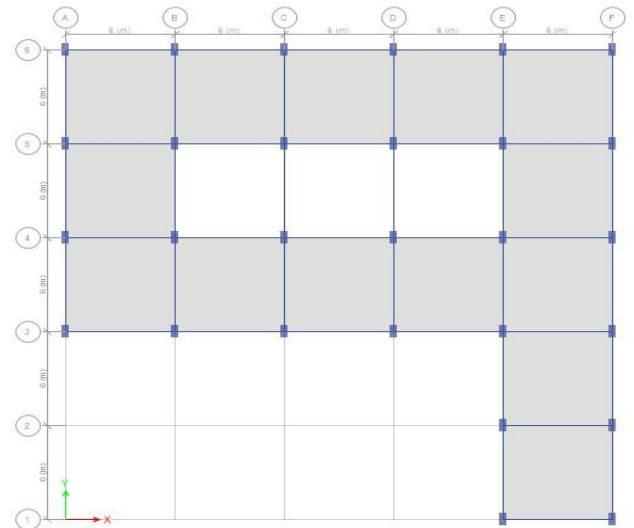
**Fig. 7: MODEL R1 (RE ENTRANT CORNERS 40% IN X AND 40% IN Y)**



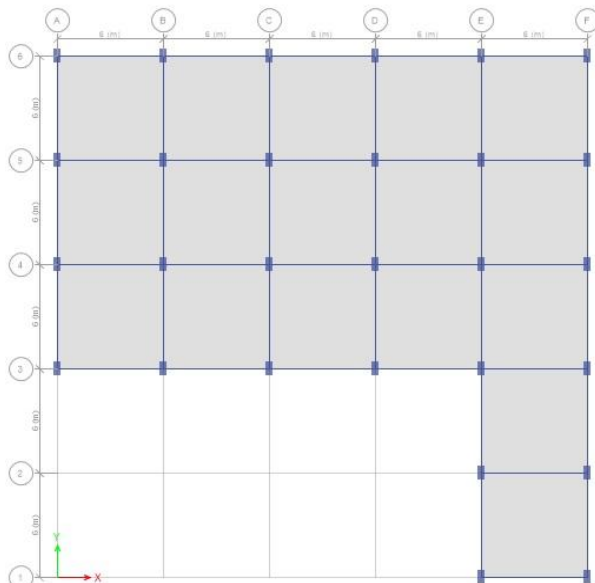
**Fig. 10: MODEL DR1 (15% diaphragm opening and 60% re-entrant in x)**



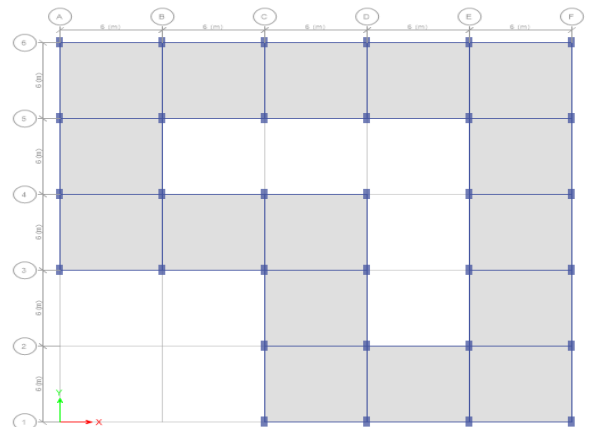
**Fig. 8: MODEL R2 (RE ENTRANT CORNERS 60% IN X AND 40% IN Y)**



**Fig. 11: MODEL DR2 (17% diaphragm opening and 80% re-entrant in x)**



**Fig. 9: MODEL R3 (RE ENTRANT CORNERS 80% IN X AND 40% IN Y)**



**Fig. 12: MODEL DR3 (23% diaphragm opening and 40% re-entrant in x)**

VII. RESULTS (Tables and graphs)

TABLE 1: Max. story displacement (mm) (ZONE IV)

| STOREY | R     | D1    | D2    | D3    | R1    | R2    | R3    | DR1   | DR2   | DR3   |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1      | 6.80  | 6.53  | 13.17 | 4.45  | 6.84  | 7.31  | 6.39  | 6.95  | 7.65  | 6.81  |
| 2      | 10.69 | 10.29 | 16.72 | 7.47  | 10.79 | 11.55 | 10.27 | 11.06 | 12.26 | 10.85 |
| 3      | 14.42 | 13.89 | 20.09 | 10.47 | 14.60 | 15.63 | 14.04 | 15.04 | 16.73 | 14.76 |
| 4      | 17.97 | 17.32 | 23.31 | 13.37 | 18.23 | 19.53 | 17.66 | 18.84 | 21.02 | 18.50 |
| 5      | 21.31 | 20.54 | 26.37 | 16.14 | 21.65 | 23.23 | 21.10 | 22.44 | 25.11 | 22.05 |
| 6      | 24.44 | 23.57 | 29.26 | 18.77 | 24.87 | 26.71 | 24.37 | 25.83 | 28.98 | 25.39 |
| 7      | 27.36 | 26.39 | 31.99 | 21.25 | 27.88 | 29.98 | 27.44 | 29.01 | 32.63 | 28.53 |
| 8      | 30.06 | 29.01 | 34.53 | 23.57 | 30.67 | 33.04 | 30.31 | 31.97 | 36.05 | 31.46 |
| 9      | 32.54 | 31.40 | 36.88 | 25.72 | 33.23 | 35.86 | 32.97 | 34.71 | 39.22 | 34.17 |
| 10     | 34.79 | 33.98 | 39.02 | 27.70 | 35.57 | 38.43 | 35.41 | 37.20 | 42.14 | 36.64 |
| 11     | 36.78 | 35.50 | 40.94 | 29.48 | 37.64 | 40.75 | 37.61 | 39.43 | 44.77 | 38.86 |
| 12     | 38.50 | 37.16 | 42.61 | 31.03 | 39.43 | 42.76 | 39.53 | 41.37 | 47.09 | 40.80 |
| 13     | 39.90 | 38.51 | 43.99 | 32.34 | 40.91 | 44.45 | 41.15 | 42.98 | 49.06 | 42.42 |
| 14     | 40.95 | 39.52 | 45.08 | 33.39 | 42.03 | 45.76 | 42.46 | 44.23 | 50.66 | 43.67 |

TABLE 2: Max. story drift (ZONE IV)

| Sty. | R       | D1      | D2      | D3      | R1      | R2      | R3      | DR1     | DR2     | DR3     |
|------|---------|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| 1    | 0.00131 | 0.00126 | 0.00140 | 0.00090 | 0.00132 | 0.00141 | 0.00127 | 0.00136 | 0.00151 | 0.00133 |
| 2    | 0.00130 | 0.00125 | 0.00119 | 0.00101 | 0.00132 | 0.00141 | 0.00129 | 0.00137 | 0.00154 | 0.00135 |
| 3    | 0.00125 | 0.00121 | 0.00114 | 0.00100 | 0.00128 | 0.00137 | 0.00126 | 0.00134 | 0.00150 | 0.00131 |
| 4    | 0.00120 | 0.00116 | 0.00110 | 0.00098 | 0.00123 | 0.00132 | 0.00122 | 0.00129 | 0.00146 | 0.00127 |
| 5    | 0.00115 | 0.00111 | 0.00107 | 0.00095 | 0.00118 | 0.00128 | 0.00118 | 0.00124 | 0.00141 | 0.00122 |
| 6    | 0.00110 | 0.00107 | 0.00103 | 0.00091 | 0.00113 | 0.00123 | 0.00114 | 0.00119 | 0.00136 | 0.00118 |
| 7    | 0.00106 | 0.00102 | 0.00099 | 0.00088 | 0.00108 | 0.00118 | 0.00110 | 0.00114 | 0.00131 | 0.00113 |
| 8    | 0.00101 | 0.00097 | 0.00094 | 0.00084 | 0.00103 | 0.00113 | 0.00105 | 0.00109 | 0.00126 | 0.00108 |
| 9    | 0.00095 | 0.00092 | 0.00089 | 0.00080 | 0.00098 | 0.00107 | 0.00100 | 0.00104 | 0.00120 | 0.00103 |
| 10   | 0.00089 | 0.00085 | 0.00083 | 0.00075 | 0.00091 | 0.00101 | 0.00094 | 0.00097 | 0.00113 | 0.00097 |
| 11   | 0.00081 | 0.00078 | 0.00075 | 0.00069 | 0.00084 | 0.00092 | 0.00086 | 0.00089 | 0.00104 | 0.00089 |
| 12   | 0.00071 | 0.00069 | 0.00067 | 0.00061 | 0.00074 | 0.00082 | 0.00076 | 0.00079 | 0.00093 | 0.00079 |
| 13   | 0.00060 | 0.00057 | 0.00056 | 0.00052 | 0.00062 | 0.00070 | 0.00065 | 0.00066 | 0.00080 | 0.00067 |
| 14   | 0.00045 | 0.00043 | 0.00043 | 0.00041 | 0.00047 | 0.00054 | 0.00051 | 0.00051 | 0.00064 | 0.00052 |



## Seismic Impact of Re-entrant Corner with Opening in Diaphragm on RC Building

**TABLE 3: Overturning moment (ZONE IV)**

| Sty. | R      | D1     | D2     | D3    | R1     | R2    | R3    | DR1   | DR2   | DR3   |
|------|--------|--------|--------|-------|--------|-------|-------|-------|-------|-------|
| 0    | 120840 | 114672 | 100007 | 78406 | 102224 | 88303 | 74918 | 83088 | 84111 | 88269 |
| 1    | 108500 | 102848 | 89784  | 70504 | 91783  | 79400 | 67169 | 74669 | 75723 | 79276 |
| 2    | 96672  | 91493  | 79966  | 62948 | 81776  | 70887 | 59724 | 66617 | 67731 | 7064  |
| 3    | 85336  | 80604  | 70519  | 55710 | 72187  | 62734 | 52585 | 58909 | 60094 | 62416 |
| 4    | 74454  | 70159  | 61407  | 48749 | 62982  | 54897 | 45739 | 51511 | 52757 | 54500 |
| 5    | 63983  | 60132  | 52611  | 42032 | 54127  | 47333 | 39174 | 44383 | 45662 | 46884 |
| 6    | 53909  | 50520  | 44139  | 35543 | 45608  | 40020 | 32887 | 37505 | 38777 | 39550 |
| 7    | 44253  | 41347  | 36030  | 29289 | 37442  | 32970 | 26896 | 30885 | 32099 | 32510 |
| 8    | 35076  | 32674  | 28358  | 23309 | 29682  | 26226 | 21238 | 24563 | 25667 | 25807 |
| 9    | 26492  | 24604  | 21233  | 17680 | 22422  | 19876 | 15981 | 18616 | 19561 | 19523 |
| 10   | 18670  | 17288  | 14806  | 12510 | 15805  | 14053 | 11220 | 13165 | 13912 | 13781 |
| 11   | 11820  | 10912  | 9252   | 7950  | 10007  | 8922  | 7075  | 8364  | 8890  | 8739  |
| 12   | 6196   | 5702   | 4778   | 4183  | 5246   | 4688  | 3692  | 4399  | 4705  | 4588  |
| 13   | 2130   | 1953   | 1617   | 1440  | 1803   | 1614  | 1261  | 1515  | 1633  | 1577  |
| 14   | 0      | 0      | 0      | 0     | 0      | 0     | 0     | 0     | 0     | 0     |

**TABLE 4: MAX. STORY DISPLACEMENT (MM) (ZONE V)**

| STOREY | R     | D1    | D2    | D3    | R1    | R2    | R3    | DR1   | DR2   | DR3   |
|--------|-------|-------|-------|-------|-------|-------|-------|-------|-------|-------|
| 1      | 10.20 | 9.805 | 19.75 | 6.67  | 10.24 | 10.97 | 9.59  | 10.43 | 11.48 | 10.22 |
| 2      | 16.04 | 15.42 | 25.08 | 11.20 | 16.19 | 17.33 | 15.41 | 16.60 | 18.39 | 16.28 |
| 3      | 21.64 | 20.84 | 30.13 | 15.70 | 21.90 | 23.45 | 21.07 | 22.57 | 25.10 | 22.15 |
| 4      | 26.95 | 25.98 | 34.96 | 20.05 | 27.34 | 29.30 | 26.49 | 28.27 | 31.54 | 27.76 |
| 5      | 31.96 | 30.82 | 39.55 | 24.21 | 32.48 | 34.84 | 31.66 | 33.67 | 37.67 | 33.08 |
| 6      | 36.66 | 35.36 | 43.90 | 28.16 | 37.31 | 40.07 | 36.55 | 38.75 | 43.47 | 38.09 |
| 7      | 41.04 | 39.59 | 47.98 | 31.88 | 41.82 | 44.98 | 41.16 | 43.52 | 48.95 | 42.80 |
| 8      | 45.10 | 43.51 | 51.80 | 35.36 | 46.00 | 49.56 | 45.46 | 47.96 | 54.07 | 47.19 |
| 9      | 48.82 | 47.11 | 55.32 | 38.59 | 49.85 | 53.79 | 49.46 | 52.06 | 58.84 | 51.25 |
| 10     | 52.19 | 50.36 | 58.54 | 41.55 | 53.35 | 57.65 | 53.12 | 55.80 | 63.21 | 54.96 |
| 11     | 55.18 | 53.25 | 61.41 | 44.22 | 56.46 | 61.12 | 56.42 | 59.15 | 67.16 | 58.29 |
| 12     | 57.75 | 55.73 | 63.91 | 46.55 | 59.15 | 64.15 | 59.30 | 62.06 | 70.64 | 61.20 |
| 13     | 59.85 | 57.76 | 65.99 | 48.52 | 61.37 | 66.67 | 61.73 | 64.48 | 73.59 | 63.63 |
| 14     | 61.42 | 59.28 | 67.62 | 50.08 | 63.05 | 68.64 | 63.70 | 66.35 | 75.99 | 65.51 |

Table 5: max. story drift (ZONE V)

| Sty | R      | D1     | D2     | D3     | R1     | R2     | R3     | DR1    | DR2    | DR3    |
|-----|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1   | .00196 | .00189 | .00210 | .00141 | .00199 | .00212 | .00191 | .00204 | .00227 | .00200 |
| 2   | .00195 | .00188 | .00179 | .00152 | .00198 | .00212 | .00194 | .00206 | .00231 | .00202 |
| 3   | .00188 | .00182 | .00171 | .00151 | .00192 | .00206 | .00190 | .00200 | .00226 | .00197 |
| 4   | .00181 | .00175 | .00166 | .00147 | .00185 | .00199 | .00184 | .00193 | .00219 | .00191 |
| 5   | .00173 | .00167 | .00160 | .00142 | .00177 | .00192 | .00177 | .00186 | .00211 | .00184 |
| 6   | .00166 | .00160 | .00155 | .00137 | .00170 | .00184 | .00171 | .00179 | .00204 | .00177 |
| 7   | .00159 | .00153 | .00148 | .00132 | .00163 | .00177 | .00165 | .00172 | .00197 | .00170 |
| 8   | .00151 | .00146 | .00142 | .00126 | .00155 | .00170 | .00152 | .00164 | .00189 | .00163 |
| 9   | .00143 | .00138 | .00134 | .00120 | .00147 | .00161 | .00150 | .00156 | .00180 | .00155 |
| 10  | .00133 | .00128 | .00125 | .00128 | .00137 | .00151 | .00141 | .00146 | .0017  | .0014  |
| 11  | .00122 | .00117 | .00113 | .00103 | .00126 | .00139 | .00129 | .00134 | .00156 | .00133 |
| 12  | .00107 | .00103 | .00100 | .00092 | .00111 | .00124 | .00115 | .00119 | .00140 | .00119 |
| 13  | .00090 | .00086 | .00084 | .00078 | .00093 | .00104 | .00097 | .00100 | .00120 | .00100 |
| 14  | .00068 | .00065 | .00065 | .00062 | .00071 | .00081 | .00079 | .00077 | .00096 | .0007  |

TABLE 6: overturning moment (ZONE V)

| STORY | R      | D1     | D2     | D3     | R1     | R2     | R3     | DR1    | DR2    | DR3    |
|-------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 0     | 181261 | 172009 | 150011 | 117609 | 153336 | 132455 | 112377 | 124633 | 126167 | 132404 |
| 1     | 162751 | 154272 | 134676 | 105756 | 137675 | 119101 | 100753 | 112004 | 113585 | 118915 |
| 2     | 145009 | 137240 | 119949 | 94423  | 122665 | 106331 | 89587  | 99925  | 101596 | 105996 |
| 3     | 128005 | 120906 | 105778 | 83565  | 108280 | 94101  | 78878  | 88364  | 90141  | 93624  |
| 4     | 111681 | 105238 | 92110  | 73124  | 94473  | 82346  | 68609  | 77267  | 79135  | 81750  |
| 5     | 95975  | 90199  | 78917  | 63049  | 81190  | 71000  | 58761  | 66575  | 68494  | 70326  |
| 6     | 80864  | 75780  | 66209  | 53315  | 68412  | 60031  | 49331  | 56258  | 58166  | 59325  |
| 7     | 66379  | 62021  | 54046  | 43933  | 56163  | 49455  | 40344  | 46328  | 48149  | 48765  |
| 8     | 52614  | 49012  | 42537  | 34964  | 44523  | 39339  | 31857  | 36844  | 38500  | 38710  |
| 9     | 39738  | 36907  | 31850  | 26520  | 33633  | 29815  | 23971  | 27924  | 29341  | 29284  |
| 10    | 28006  | 25932  | 22209  | 18765  | 23707  | 21080  | 16830  | 19748  | 20869  | 20672  |
| 11    | 17730  | 16368  | 13878  | 11925  | 15011  | 13383  | 10612  | 12546  | 13336  | 13109  |
| 12    | 9294   | 8553   | 7168   | 6275   | 7870   | 7032   | 5538   | 6598   | 7057   | 6882   |
| 13    | 3195   | 2929   | 2426   | 2160   | 2704   | 2421   | 1892   | 2273   | 2449   | 2366   |
| 14    | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      | 0      |

# Seismic Impact of Re-entrant Corner with Opening in Diaphragm on RC Building

TABLE 7: Base shear

| S.No. | MODELS | BASE SHEAR (ZONE IV) | BASE SHEAR (ZONE V) |
|-------|--------|----------------------|---------------------|
| 1     | R      | 4076.3465 KN         | 6114.519 KN         |
| 2     | D1     | 3872.2100 KN         | 5808.310 KN         |
| 3     | D2     | 3312.7800 KN         | 4969.170 KN         |
| 4     | D3     | 3690.9300 KN         | 5536.400 KN         |
| 5     | R1     | 3506.9188 KN         | 5260.370 KN         |
| 6     | R2     | 3122.2062 KN         | 4683.300 KN         |
| 7     | R3     | 2696.8046 KN         | 4045.200 KN         |
| 8     | DR1    | 3074.9743 KN         | 4612.46 KN          |
| 9     | DR2    | 3165.2912 KN         | 4747.937 KN         |
| 10    | DR3    | 3160.2926 KN         | 4740.438 KN         |

## GRAPHS

### ZONE IV

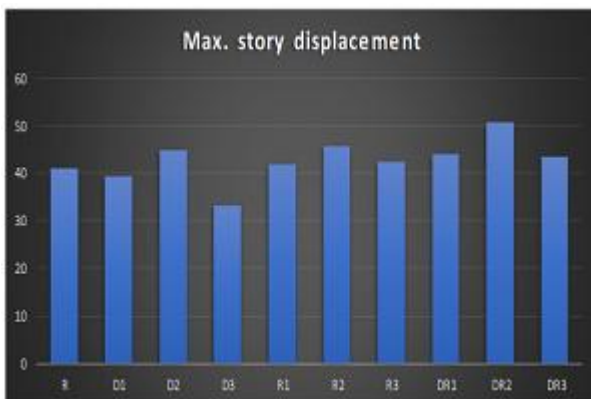


Fig. 13: Max. story displacement



Fig. 14: max. storey drift

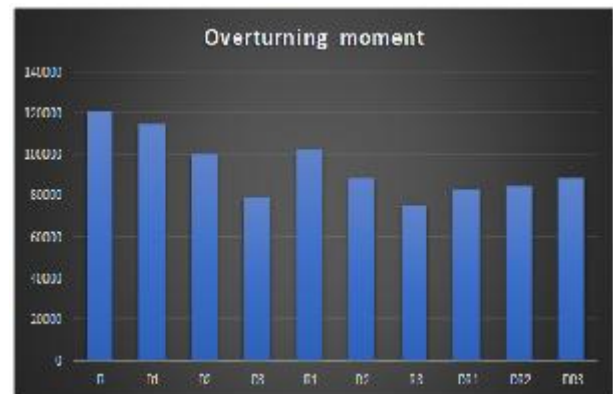


Fig. 15: Overturning moment

### ZONE V



Fig. 16: max. storey displacement



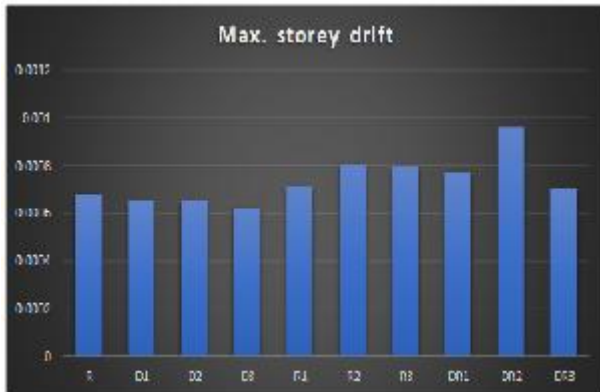


Fig.17: max. story drift



Fig. 18: overturning moments

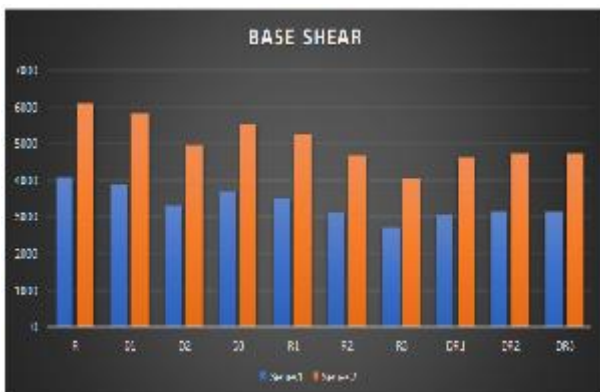


Fig. 19: base shear

## VII. CONCLUSION

Seismic response of plan irregular building in two different zones IV and V are studied. After study of results obtained from the analysis of structure, following conclusion can be made-

- 1) For base shear (refer table 7 and fig. 19), regular building shows max. lateral force at the base. Irregular plan building shows decrease in the value of base shear when percentage of irregularity increases. But when it comes combined irregular building model DR2 shows max. base shear. Hence, we can also say weight of building also affects base shear, more weight more base shear.
- 2) For max. displacement (fig. 16 and 13), model DR2 shows maximum for both zones and model D3 shows least displacement. By this we can say that diaphragm opening not much effect the displacement but

re-entrants do. And combination of both makes structure more unstable.

- 3) When it comes to story drift (refer Fig. 14 and 17) from results, we can see that more percentage of opening less drift value and more varying percentage re-entrant more drift. Therefore, when it comes to the combination of two models DR2 shows max. drift for both zones.
- 4) Models R shows max. overturning moment (refer fig. 18 and 15) and as opening in slabs increases it reduces. Similarly, it is for re-entrant corner models. But for the combination of two irregularity there is an increase in overturning moment as varying percentage increases. Hence, we can say that large slab opening results in less overturning moment.

Hence, it can be seen that due to more weight of the building base shear and overturning moment is more and due to unsymmetry of the structure max. displacement and story drift is more.

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## AUTHORS PROFILE



**Md Faisal Zia** is a post graduate student from specialization in structural engineering, department of civil engineering from Integral University, Lucknow, Uttar Pradesh. He did his Bachelor of Technology in Civil Engineering from Sharda University, Greater Noida in the year 2016, Uttar Pradesh. He is having two years of experience in building construction. His area of interest is high rise building design and analysis and seismic effect on high rise building. He is also having good communication skills and knowledge regarding structure of buildings. He also has good working experience in architectural design of building. Presently he is pursuing master degree.



**Mr. Rajiv Banerjee** is currently working as an Associate professor, department of civil engineering, Integral University, Lucknow, Uttar Pradesh. He completed his Master in Technology degree from Calcutta University, West Bengal and Bachelor of Tech from IIT, BHU. He is also a Ph.D. student from Dr. A.P.J. Abdul Technical University, Lucknow. He retired from the post of executive Engineer in municipal engineering directorate, Govt. of West Bengal. He also has an experience of eight years in academics and twenty-seven years of experience in construction industry. He is also specialized in environmental engineering, infrastructure Planning and Contract Management.