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A Literature Review on Analytical Modelling of T-Shaped Monolithic and Independent RCC Buildings.

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ABSTRACT:

Weather changes have a huge negative impact on the ecosystem and might suddenly precipitate natural disasters. There are numerous machine learning During an earthquake the behaviour of the building depends on its overall shape, size & geometry. Now a day's many buildings are asymmetric in plan and elevation because everyone wants to win the race of aesthetically beautiful and complex structures. Due to irregular distribution of mass, stiffness and strength, it may cause serious damage in structural system. There are various types of irregularities in the buildings depending upon their location and scope. Mainly two types of irregularities as per ***IS – 1893 (Part-1)-2002***. are a) plan or horizontal irregularities b) vertical irregularities. Irregularity in structure makes analysis of the seismic behaviour very complicated. The objective of present study is to analyze and compare the behaviour of T shape monolithic and independent RCC structure under seismic loading. The comparison of both structures is studied by calculating, finding and tabulating comparative values of displacement, base moments and shear values. The study reflects that with change in structure i.e. the behaviour of structure towards earthquake changes, nodal displacement, moment, and base shear values shows drastic changes towards resistivity against seismic forces. The soft computing tool and commercial software ***STAAD-Pro*** is used for modelling and analysis also the study done over here thus helps to understand effect of earthquake on both structures for achieving stable and safe structure.

Keywords: Seismic, RCC structures, Asymmetric structures, IS – 1893 (Part-1)-2002, Base Shear, Nodal displacement, Support Reactions, Shear Force.

Introduction:

Earthquakes are may be the most unpredictable and disturbing of all natural disasters. They not only cause great damage in terms of human loss in numerical strength through a cause, as a death, but also have a great cost-effective impact on affected vicinity. An earthquake is a sudden movement of the earth's crust, which originate naturally at or below the surface, because of release of strain energy or movement of tectonic plates. Due to development of concentration currents, the plates move apparently towards each other or away from each other. This movement of the surface develops inertia forces on the structural lines over it. This causes damage to or collapse of buildings and other man-made structures. Experience has shown that for new constructions, establishing earthquake resistant regulations and their implementation is the critical safeguard against earthquakeinduced damage. As regards existing structures, it is necessary to evaluate and strengthen them based on evaluation criteria before an earthquake.

Earthquake damage depends on many parameters, including intensity, duration and frequency content of ground motion, geologic and soil condition, quality of construction, symmetry of structure etc. Out of all the factors asymmetry can be the most important reason for a building's poor performance under severe seismic loading. Buildings may be considered as asymmetric in plan or in elevation based on the distribution of mass and stiffness along each storey, throughout the height of the buildings. Seismic behavior of asymmetric building may cause interruption of force flow and stress concentration. Due to this, there is produce of torsion in the building which leads to increase in shear force, lateral deflection and ultimately causes failure. The buildings with vertical setbacks and L, H, U or T shaped in plans which built as unit are more affected during seismic event. Therefore, building design must be such as to ensure that the building has adequate strength, high ductility, and will remain as one unit, even while subjected to very large deformation, so that we need to provide earthquake resistive building.

Conventional seismic design attempts to make buildings that do not collapse under strong earthquake shaking, but may sustain damage to non-structural elements and to some structural members in the building. Reinforced cement concrete (RCC) has been the most popular construction material used worldwide in the past century. It has proven to be a wonderful construction material that possesses almost all of the desirable properties such as excellent insulation from environment, durability, low cost, ease of construction, ability to mould in any given shape to name a few. Even from structural aspects, reinforced concrete construction serves its intended purpose extremely well, if properly designed and constructed. However, the performance of reinforced concrete structures during past earthquakes has forced researchers to evaluate the suitability of the material to resist seismic excitations. The high yield and ultimate strength result in slender sections. These properties of steel are of very much vital in case of the seismic resistant design. In the past, for the design of a building, the choice was normally between a concrete structure and a masonry structure. But the failure of many multi-storied and low-rise R.C.C. and masonry buildings due to earthquake has forced the structural engineers to look for the resistive technique for construction. This may render the building non-functional after the earthquake, which may be problematic in some structures, like hospitals, which need to remain functional in the aftermath of earthquake. Special techniques are required to design buildings such that they remain practically undamaged even in a severe earthquake. Buildings with such improved seismic performance usually cost more than the normal buildings do.

Aim :- To study analytical modelling of T-shaped monolithic & independent RCC buildings.

Objective :-

1. To study the conceptual tips for earthquake resistive structure.
2. To study the effect of seismic forces on RCC superstructure.
3. To study the seismic forces on T shape RCC building.
4. To compare monolithic and independent T shape RCC building.
5. The building is to be analyzed by using structural software package ***STAAD-Pro.***

Scope :-

The seismic analysis of a G+4 RCC framed T shape structure with following details is carried out using STAAD Pro software.

1. Zone – III
2. Soil condition – Medium soil
3. Frame type - Ordinary Moment Resisting Frame (OMRF)

Need :-

1. Its use for safety from earthquake.
2. Its use to get increase life span of structure.
3. Its need for economical RCC structure.
4. Its techniques use in earthquakes zone area etc.

LITERATURE REVIEW :

N.W.Mankar.et.al.(13), This work is on a T shape building, the rotational flexibility on the Tshape building and a part of T shape building reduced from 100 % to 0 %. So. The soft computing tool and commercial software STAAD-Pro is used for modeling and analysis. Building plans of odd shapes shows an erratic development of forces. By introducing the rotational flexibility, forces can be reduced to some level, however precaution is necessary while introducing retentional flexibility.

Mohit Sharma. et.al.(14), In this paper RCC frame structure is analyzed both statically and dynamically. It is seen that to develop a simple analytical procedure based on rigorous computations and experiments on the seismic response of irregular structures is necessary.

Ubhadiya Bimal D.et.al.(17), In this study, different basic insulation methods were used to study the vibration responses of the most common buildings in the plan, and the scope analysis of the building models response was performed with ETABS 2017. The study also compared the performance of three unusual L-shaped, T-shaped and Plus shaped buildings with a single area. 9 Multi-storey building models selected which contain G+10 number of storey and total number columns are 48 and beams are 80, M-30 concrete and Fe-415 grade steel is used for designing.

METHODOLOGY:

A brief overview of steps needed for the completion of this dissertation is given below.

- PHASE I

a. Introduction

A general idea about the topic along with need and scope is stated.

b. Literature Review

Literatures of various work done previously are reviewed.

c. Methodology

Total breakdown structure of line of work is given.

- PHASE II

Detail study :-

Various types of seismic forces, analysis for various case considerations, analysis of Normal RCC frame G+4 structure (T shape), design procedure for RCC framed structure, various load cases, seismic considerations in IS 1893:2002, IS 13920:2012 are studied.

- PHASE III

a. Observations

Observations obtained from the various analysis is done.

b. Results

Results are derived on the basis of the analysis.

c. Conclusion & Limitation

Conclusion of the dissertation is stated along with the various limitations.

d. Future Scope

Future scope for further work regarding this topic is stated.

e. References

Various literatures reviewed are entitled.

DETAIL STUDY :

- RCC STRUCTURE SUBJECTED TO SEISMIC LOAD

Earthquake which is defined as ground motion caused by a sudden movement of the Earth's tectonic plates, may cause loss of lives, also the structures resting on the earth surface, experience ground motion and hence undergoes damage or may totally collapse. This leads to loss of lives and enormous loss in property which ultimately leads to economic loss in a country. Since earthquakes cannot be predicted, structures are made resistant in such a way that they might undergo partial damage but will not totally collapse during an earthquake. Apart from strength and deformation capacity, earthquake resistant design of structures also focuses on ductility, which is an ability of a structure to face huge plastic deformation without loss in strength. This can be achieved by making sure that the available ductility is more than the required ductility.

Structures are generally made up of a combination of flexible and stiff parts. This ensures that the seismic energy passed on to the structure is first absorbed in the flexible part and then gets transferred onto the stiff part. During an earthquake, the columns of the structures act as primary members which resist the seismic forces, owing to this fact it is seen that the use of corrosion resistant hybrid columns in Reinforced Concrete (RC) structures can reduce the residual displacement and also have enough energy dissipation capacity during earthquake excitations. It is also seen that in areas of high seismic risk RC wall frame structures are constructed as it provides stiffness to the system's lateral force resistance, and also behave as ductile structures.

A earthquake resistive structure having properties of RCC materials. So, it is necessary to study the structure under the effect of seismic forces. The study is concerned with the right analysis for the structures and looking after the construction process so that the longevity of the earthquake resistive structures is guaranteed after construction. Construction technique for structure should also be satisfactory for the public terms of comfort. The primary design technologies are to control or remediate earthquake effects.

Thus, the various parameters like displacement, storey drift, reactions and shear forces are studied and compared.

a) The present study is limited to RCC framed structure.

b) Framed structure with T shape & G+4 storeys is considered.

c) Soil-structure interaction effects are not considered in the present study.

The various parameters used in the seismic analysis of RCC framed structure, are considered from IS 1893: 2002, "Code for earthquake resistant design of structures- general provisions for buildings, Part I, Bureau of Indian Standards.

- MODEL FORMULATION

The study is disbursed on a T shape monolithic and independent building. The plan layout of the building is shown within the figure. The building is taken into account as residential building having G+4. Height of every storey is kept same as other prevalent data.

- LOAD COMBINATION AND INCREASE IN PERMISSIBLE STRESSES

(IS 1893 (Part I) : 2002, Clause 6.3)

When earthquake forces are considered on a structure, these shall be combined as below where the terms DL, IL and EL stand for the response quantities due to dead load, imposed load and designated earthquake load respectively.

Load factors for plastic design of steel structures

In the plastic design of steel structures, the following load combinations shall be accounted for:

1) 1.7 (DL + IL)

2) 1.7 (DL ± EL)

3) 1.3 (DL + IL ± EL)

Partial safety factors for limit state design of reinforced concrete and pre-stressed concrete structures

In the limit state design of reinforced and pre-stressed concrete structures, the following load combinations shall be accounted for:

1) 1.5 (DL + IL)

2) 1.2 (DL + ZL ± EL)

3) 1.5 (DL ± EL)

4) 0.9 (DL ± 1.5 EL)

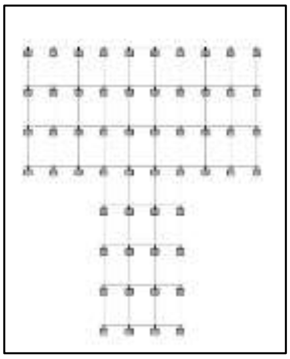

FIG.1 WHOLE STRUCTURE –PLAN (MONOLITHIC)

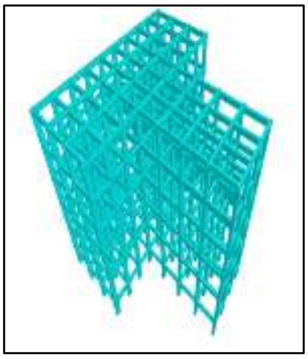

FIG.2 WHOLE STRUCTURE-3D (MONOLITHIC)

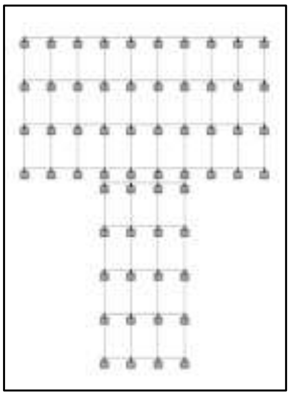

FIG.3 WHOLE STRUCTURE –PLAN (INDEPENDENT)

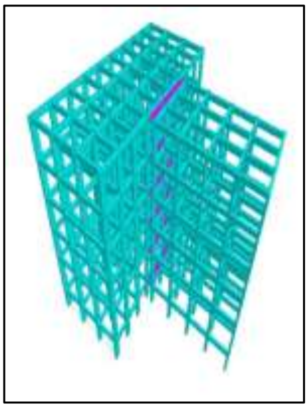

FIG.4 WHOLE STRUCTURE-3D (INDEPENDENT)

- METHOD ADOPTED IS AS FOLLOWS

Step 1: Parameters of beam and column sections The codes IS 456-2000 and IS 800-2007 are used for RCC and Steel section. The RCC beam and column sections provided are 0.23m x 0.45m and 0.23m x 0.6m resp. A structural model is a diagram which consists of a set of nodes and connections between the nodes. Analysis process of frames is conducted on a model based on many assumptions including those for the structural model, the geometric behaviour of the structure and its members and the behaviour of the sections and joints.

Step 2: Analysis : Each type of frame is analyzed separately by using ***STAAD.Pro*** V8i .The analysis is conducted for IS 1893(Part 1), 2002 and IS 800-2007 specified combinations of loadings.

Step 3: Comparison of results : The results will be obtained by seismic analysis and are compared in terms mentioned below for monolithic T shape RCC framed and independent T shape RCC frame.

- Lateral displacement in longitudinal and transverse direction
- Storey drift in longitudinal and transverse direction
- Reactions at the bottom supports of edge sections
- Maximum forces i.e. Axial forces, Shear forces and Bending moments in all directions.
- Nodal displacements in edge nodes for RCC section.
- Maximum forces induced in top edge column.
- Maximum forces induced in top edge beam

➢ LIST OF IS CODE EMPLOYED IN ANALYSIS

- IS 456-2000 Plain and concrete
- IS-SP-16:1980 for R.C Column Design
- IS 875-1987 Part-I for load
- IS 875-1987 Part-II for loading
- IS 875-1987 Part-III for Wind Load

OBSERVATION AND REMARK :

With the aim of comparing the behavior of both monolithic and independent T shape RCC structure under seismic loading, Various cases are modeled analyzed in the previous chapter no.4. Each case represents change in modeling for T shape RCC structure and comparison is made over here. The various cases analyzed are :

Case I: - T shape RCC structure subjected to seismic loading (Monolithic Structure).

Case II: - T shape RCC structure subjected to seismic loading (Independent Structure).

On the basis of this case analysis, the observation related to nodal displacement value at various location along the height, reaction summary, storey drift value are depicted in the tables below.

➢ Nodal Displacement Of Column Location At Corner Edge

RESULTANT DISPLACEMENT		
NODE NO.	MONOLITHIC	INDEPENDENT
	CASE 1	CASE 2
61	80.22	68.65
51	74.35	63.71
41	64.05	54.61
31	50.82	43.17
21	35.5	30.08
11	4.7	3.98

From table, the study of the displacement for column junction at the corner edge is done. Case I is the structure with monolithic T shape while Case II is the result for independent T shape structure. It is very clear from the table that resultant displacement for outer corner column edge is more for the monolithic T structure. It is also observed that the displacement is maximum for 1st storey for both the cases.

➢ Nodal Displacement Of Column Location At Outer Junction

RESULTANT DISPLACEMENT		
NODE NO.	MONOLITHIC	INDEPENDENT
	CASE 1	CASE 2
274	79.81	64.8
264	74.11	59.9
254	63.9	51.62

244	50.89	41.02
234	35.84	28.83
224	4.7	3.75

In table the comparative analysis for the column edge at the junction of T but outer face is shown. Again from the observation table it is clearly seen that displacement value for T structure is more for monolithic structure. Also the displacement value is more for storey number 1.

➢ Nodal Displacement Of Column Location At Inner Junction

RESULTANT DISPLACEMENT		
NODE NO.	MONOLITHIC	INDEPENDENT
	CASE 1	CASE 2
275	79.6	64.324
265	73.93	59.07
255	63.92	51.56
245	50.87	40.8
235	35.88	28.8
225	4.69	3.72

From table the values of the forces are undertaken for both the cases. Values of displacement again in monolithic T structure is more.

➢ Storey Drift Values At Corner Edge

CASE-I

NODE NO.	RESULTANT DISPLACEMENT	DELTA
61	80.22	-
51	74.35	5.87
41	64.05	10.3
31	50.82	13.23
21	35.5	15.32
11	4.7	30.8

CASE-II

NODE NO.	RESULTANT DISPLACEMENT	DELTA
61	68.65	-
51	63.71	4.94
41	54.61	9.1
31	43.17	11.44
21	30.08	13.09
11	3.98	26.1

From table - Case I, It is observed that storey drift value is maximum for storey number 1 and this is same for case II also. The relative displacement i.e storey drift is more for the structure with monolithic T shape.

➢ Storey Drift Values At Outer Junction

CASE-I

NODE NO.	RESULTANT DISPLACEMENT	DELTA
274	79.81	-
264	74.11	5.7
254	63.9	10.21
244	50.89	13.01
234	35.84	15.05
224	4.7	31.14

CASE-II

NODE NO.	RESULTANT DISPLACEMENT	DELTA
274	64.8	-

264	59.9	4.9
254	51.62	8.28
244	41.02	10.6
234	28.83	12.19
224	3.75	25.08

From table - Case I, It is observed that storey drift value is maximum for storey number 1 and this is same for case II also. The relative displacement i.e storey drift is more for the structure with monolithic T shape.

- Storey Drift Values At Inner Junction

CASE-I

NODE NO.	RESULTANT DISPLACEMENT	DELTA
275	79.6	-
265	73.93	5.67
255	63.92	10.01
245	50.87	13.05
235	35.88	14.99
225	4.69	31.19

CASE-II

NODE NO.	RESULTANT DISPLACEMENT	DELTA
275	64.324	-
265	59.07	5.25
255	51.56	7.51
245	40.8	10.76
235	28.8	12
225	3.72	25.08

From table - Case I, It is observed that storey drift value is maximum for storey number 1 and this is same for case II also. The relative displacement i.e storey drift is more for the structure with monolithic T shape.

Conclusion

With the aim of comparing the behaviour of both monolithic and independent T shape RCC structure under seismic loading, various cases are analysed and the comparison is made related to nodal displacement, support reaction and storey drift value. On the basis of this analysis the observation and remarks are made.

It is observed that the nodal displacement, shear values reactions as well as drift values are more for the T shape structure which is monolithically constructed while the same structure is provided in the form of two rectangles to form T shape. There is drastic fall in values of forces, reactions, displacement, and drift.

From the study, analysis and comparison it can be handled in good way if it is provided in the independent rectangle arrangement.

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