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Analysis of Reinforced Concrete Building with Different Arrangement of Concrete and Steel Bracing system

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Abstract: *Concrete braced and steel braced reinforced concrete frame is one of the structural systems used to resist earthquake loads in multistoried buildings. Many existing reinforced concrete buildings need retrofit to overcome deficiencies to resist seismic loads. The use of concrete and steel bracing systems for strengthening seismically inadequate reinforced concrete frames is a viable solution for enhancing earthquake resistance. Concrete and steel bracing is economical, easy to erect, occupies less space and has flexibility to design for meeting the required strength and stiffness.*

In this study, *the seismic analysis of reinforced concrete (RC) buildings with different types of bracing (Diagonal, V type, Inverted V type, Combine V type, K type, X type) is studied. The bracing is provided for peripheral columns and any two parallel sides of building model. A thirteen-storey building is analyzed for seismic zone III as per IS 1893: 2002 using ETAB software. The percentage reduction in storey displacement is found out. It is found that the X type of concrete bracing significantly contributes to the structural stiffness and reduces the maximum storey drift of the frames. The bracing system improves not only the stiffness and strength capacity but also the displacement capacity of the structure.*

I. Introduction

The primary purpose of all kinds of structural systems used in the building type of structures is to transfer gravity loads effectively. The most common loads resulting from the effect of gravity are dead load, live load and snow load. Besides these vertical loads, buildings are also subjected to lateral loads caused by wind, blasting or earthquake. Lateral loads can develop high stresses, produce sway movement or cause vibration. Therefore, it is very important for the structure to have sufficient strength against vertical loads together with adequate stiffness to resist lateral forces.

Strengthening of structures proves to be a better option catering to the economic considerations and immediate shelter problems rather than replacement of buildings. Moreover it has been often seen that retrofitting of buildings is generally more economical as compared to demolition and reconstruction. Therefore, seismic retrofitting or strengthening of building structures is one of the most important aspects for mitigating seismic hazards especially in earthquake prone areas.

II. Strengthening Of Rc Structures With Concrete And Steel Bracing Systems

Concrete bracing and Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A number of researchers have investigated various techniques such as infilling walls, adding walls to existing columns, encasing columns, and adding concrete bracing or steel bracing to improve the strength and/or ductility of existing buildings. A bracing system improves the seismic performance of the frame by increasing its stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel bracing systems for retrofitting reinforced concrete frames with inadequate lateral resistance is attractive.

III. Motivation Of Present Work

An earthquake manifests great devastation due to unpredicted seismic motion striking extensive damage to innumerable buildings of varying degree, i.e. either full or partial. This damage to structures in turn causes irreparable loss of life with a large number of casualties. Strengthening of structures probes to be a better option catering to the economic considerations and immediate shelter problems rather than replacement of buildings. Seismic strengthning or retrofitting is generally carried out in two ways either global retrofit methods or local retrofit methods. In global retrofit methods, convential method based on increasing seismic resistance of existing structure and non-convential methods based on reduction of seismic demands are used. Steel bracing is a highly efficient and economical method of resisting horizontal forces in a frame structure. Bracing has been used to stabilize laterally the majority of the world's tallest building structures as well as one of the major retrofit measures. Bracing is efficient because the diagonals work in axial stress and therefore call for minimum member sizes in providing stiffness and strength against horizontal shear. A bracing system improves the seismic performance of the frame by increasing its lateral stiffness and capacity. Through the addition of the bracing system, load could be transferred out of the frame and into the braces, bypassing the weak columns while increasing strength. Steel-braced frames are efficient structural systems for buildings subjected to seismic or wind lateral loadings. Therefore, the use of steel-bracing systems for retrofitting reinforced-concrete frames with inadequate lateral resistance is attractive.

IV. Building Description

The RC buildings used in this study is thirteen storied. All building models have same floor plan with 4-4m bays.

4.1 The data is taken for the analysis is as follows:

- Type of frame:-Special Moment Resisting Frame
- No. of storey:- 13
- Zone (Z):- III
- Importance factor (I):- 1
- Response reduction factor (R):- 5
- Slab thickness:-125 mm
- Thickness of wall:-230mm
- Live load:-3 kN/m^2
- Height of the floor:-3 m
- Type of building:-Residential
- Soil strata:- Medium
- Density of brick:-20kN/m^3
- Density of concrete:-25kN/m^3
- M-25 concrete and FE-415 steel is used.
- The steel bracing used is ISA 110X110X10
- The modulus of elasticity of concrete and steel are 25000 N/mm^2 and 2×10^5 N/mm^2 respectively
  The cross section of beam and column used for modeling are tabulated in table 4.1

Table 4.1 Cross section property of beam and column

Building	Beam size in mm	Column size in mm
G+12	300X450	300X600

V. Conclusion

The use of concrete braced RC frames and steel braced RC frames as the main lateral load resistance system for RC structures is a promising technique. The design system should be strong enough to resist the seismic forces and light enough to keep the existing structural elements far from needing further reinforcement. Furthermore, these systems could be installed quickly and then eliminate the need to disrupt the occupants of the existing structures.The bracing system improves not only the lateral stiffness and strength capacity but also the displacement capacity of the structure.

The following conclusions are drawn based on present study.

1. Concrete bracings and Steel bracings used as an alternative to the other st renthen or retrofitting techniques available as the total weight on the existing building will not change significantly.
2. The storey displacement of bulding reduced by the use of Concrete Bracing of K type, diagonal,V type, combine V type, Inverted V type, X type of bracing system respectively and X type of bracing reduced maximum displacement. The percentage reduction in the top floor displacements for structure with X bracing with respect to that without bracing is shown in the table below.

Table 5.1 Top Floor Displacement Reduction (%)

Building	Without Bracing (mm)	Concrete X Bracing (mm)	% Reduction
G+12 (All side)	0.25	0.10	60
G+12 (Two side)	0.25	0.12	52

The storey displacement of bulding reduced by the use of Steel Bracing of K type, diagonal,X type, V type, Inverted V type, Combine V type of bracing system respectively and Combine V type of bracing reduced maximum displacement. The percentage reduction in the top floor displacements for structure with Combine V bracing with respect to that without bracing is shown in the table below.

Table 5.2 Top Floor Displacement Reduction (%)

Building	Without Bracing (mm)	Steel Combine V Bracing (mm)	% Reduction
G+12 (All side)	0.25	0.10	60
G+12 (Two side)	0.25	0.12	52

3. The x type of concrete bracing is found to most efficient in terms of storey displacement if bracing is provided on all side as well as on any two parallel sides but other types of bracing can also be used as per the site conditions and aesthetic requirements of the structure.
The combine v type of steel bracing is also found efficient in terms of storey displacement if bracing is provided on all side as well as on any two parallel sides but other types of bracing can also be used as per the site conditions and aesthetic requirements of the structure.
4. The storey drift of concrete and steel braced building is less as compared to the unbraced building thus the overall response of the building decreases.
5. If there is provision of concrete X bracing system on all sides of building as well as on any two sides of building then base shear is increased by 60% to 65% as compared to other bracing model system.
If there is provision of steel combine V bracing system on all sides of building as well as on any two sides of building then base shear is increased by 60% to 66% as compared to other bracing model system.
6. The concrete and steel braced building of base shear increases as compared to without steel bracing which indicates that stiffness of building has increased.
7. The X type of bracing is found to most efficient in terms of storey overturning moment. If concrete bracing is provided on all sides as well as on any two parallel sides of building then storey overturning moment is increased by 61% to 65% as compared to other bracing model systems.
If steel bracing is provided on all sides as well as on any two parallel sides of building then storey overturning moment is increased by 48% to 53% as compared to other bracing model systems.
Table 5.3 shows effect of different type bracing on baes shear in columns of the building. For all side bracing (peripheral bracing). The same is shown in figure 5.1 graphically.

Table 5.3 Base shear (kN)

Model	**Base Shear (kN)**	
	Concrete Bracing	**Steel Bracing**
WITHOUT bracing	42.104	42.104
DIAGONAL bracing	98.058	66.165
V Bracing	106.671	117.955
INVERTED V bracing	111.466	120.994
COMBINE V bracing	111.852	**122.326**
K bracing	65.208	56.459
X bracing	**118.998**	82.460

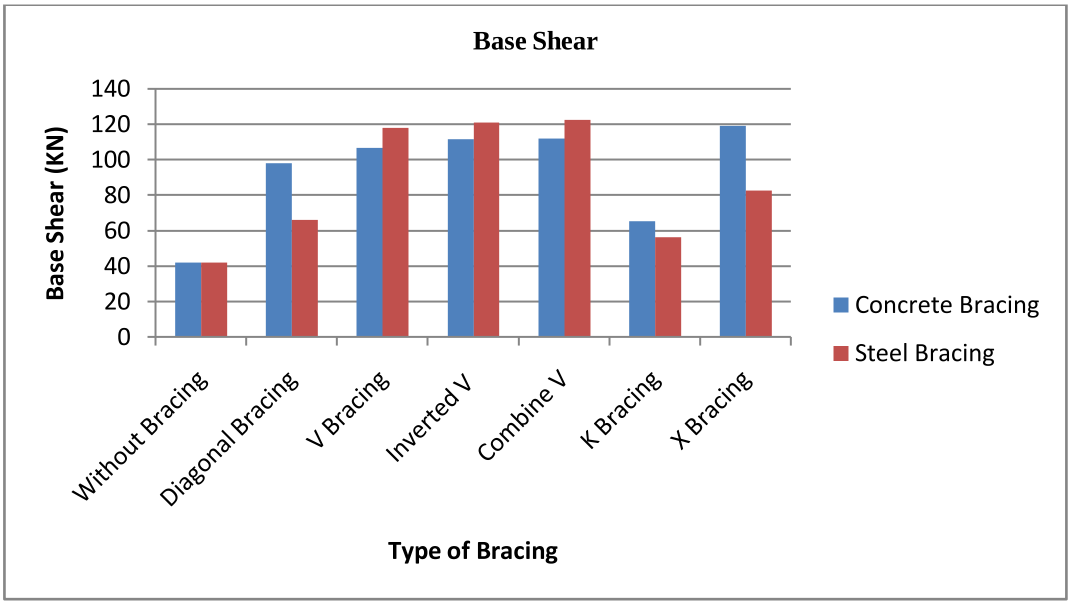

Fig 5.1: Graphical representation of Base Shear

Table 5.4 shows effect of different type bracing on baes shear in columns of the building. For any two parallel side bracing. The same is shown in figure 5.2 graphically.

Table 5.4 Base shear (kN)

Model	**Base Shear (kN)**	
	Concrete Bracing	**Steel Bracing**
WITHOUT bracing	42.104	42.104
DIAGONAL bracing	91.363	65.13
V Bracing	95.687	102.312
INVERTED V bracing	100.717	108.227
COMBINE V bracing	99.773	**108.371**
K bracing	63.402	55.822
X bracing	**105.478**	78.875

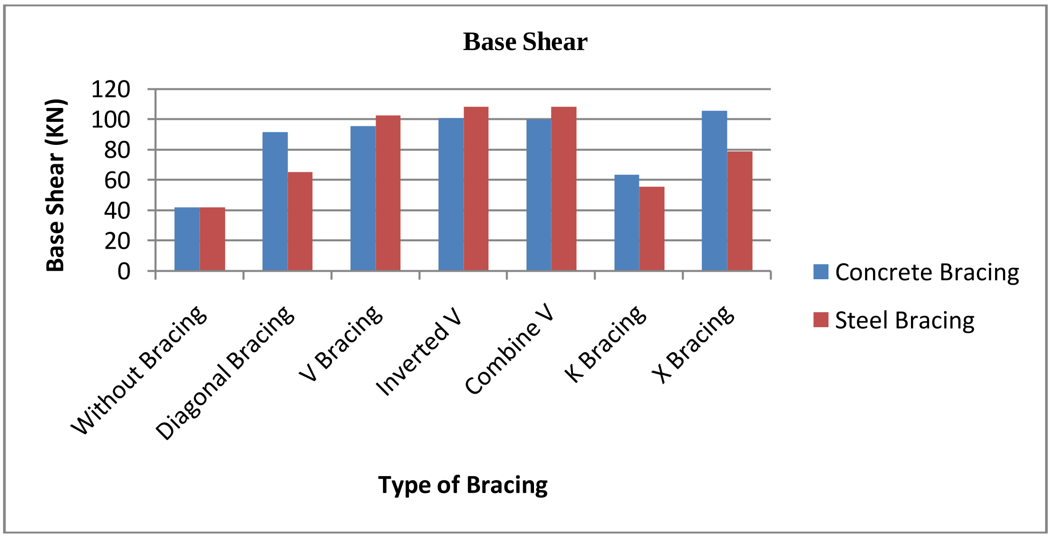

Fig 5.2: Graphical representation of Base Shear

References

Journal Papers:

[1] Dubey S.D. and Kute S. Y.(2013) "Experimental investigation on the ultimate strength of partially infilled and steel-braced reinforced concrete frames" International Journal of Advanced Structural Engineering pp.5-15

[2] Parasiya A. S and Nimodiya P. (2013) "A review on comparative analysis of brace frame with conventional lateral load resisting frame in RC structure using software" International Journal of Advanced Engineering Research and Studies pp.88-93

[3] Kevadkar M.D. and Kodag P.B., (2013) "Lateral load analysis of R.C.C. building" International Journal of Modern Engineering Research (IJMER) Vol.3, Issue.3, pp. 1428-1434.

[4] Massumi A. and Absalan M. (2013) "Interaction between bracing system and moment resisting frame in braced RC frames" Archives of Civil and Mechanical Engineering pp. 260 – 268

[5] Paul G. and Agarwal P. (2012) "Experimental verification of seismic evaluation of R C frame building designed as per previous is codes before and after retrofitting by using steel bracing" Asian journal of civil engineering (building and housing) vol. 13, pp.165-179.

[6] Ozel A. E.and Guneyisi E. M. (2010) "Effects of eccentric steel bracing systems on seismic fragility curves of mid-rise R/C buildings: A case study" Structural Safety 33 pp.82–95

[7] Viswanath K.G, Prakash K.B.and Desai A, (2010) "Seismic analysis of steel braced reinforced concrete frames." International Journal of Civil and Structural Engineering volume 1, pp.114-122

[8] Takatani T. and Ono K. (2009) "On application of ACM bracing method to seismic retrofitting work of RC-storied building" materials forum vol. 33

[9] Massumi A. and Tasnimi A.A. (2008) "Strengthening of low ductile reinforced concrete frames using steel x-bracings with different details" The 14 World Conference on Earthquake Engineering October, Beijing, China pp. 12-17

[10] Godínez Domínguez E.A. and Tena colunga A. (2008) "Behavior of moment resisting reinforced concrete concentric braced frames (RC-MRCBFS) in seismic zones" the 14th world conference on earthquake engineering

[11] Youssef M. A., and Ghaffarzadeh H.,and Nehdi M. (2007) " Seismic performance of RC frames with concentric internal steel bracing" Engineering Structures 29 pp. 1561–1568

[12] Rahai A. and Lashgari M.(2006) "Seismic strengthening of nine-storey RC building using concentric and buckling-restrained bracing" 31st conference on our world in concrete & structures, Singapore, pp. 16 – 17

[13] Bush T. D., Jones E. A. (1991) "Behavior of R.C. frame strengthened using structural steel bracing" Journal of Structural Engineering, vol.117 pp. 1115-1126.

[14] Badoux M. and Jirsa J.O. (1990), "Steel bracing of R.C. frames for seismic retrofitting" J. Struct. Eng.116 pp.55-74.

[15] Hjelmstad K. D.and Foutch D.A. and Valle E. D and Downs R.E.(1988) "Forced vibration studies of an RC building retrofit with steel bracing" Ninth World Conference on Earthquake Engineering' Tokyo-Kyoto, JAPAN. Vol.7 pp. 469-474