iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 13 **Issue:** III **Month of publication:** March 2025

DOI: https://doi.org/10.22214/ijraset.2025.67715

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 13 Issue III Mar 2025- Available at www.ijraset.com

Comparative Study of Various Seismic Analysis Methods for RC Structure

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Abstract: A large number of RC frame buildings have been built in India in recent years. Huge number of similarlydesigned andconstructed buildings exist in the various towns and cities situated in moderate to severe seismiczones of the country. Analysis and design of such buildings for static forces is a routine affair these daysbecause of availability of affordable computers and specialized programs which can be used for the analysis. Onthe other hand, dynamic analysis is a time-consuming process and requiresadditional input related to mass ofthe structure, and an understanding of structural dynamics for interpretation of analytical results. ReinforcedConcrete (RC) frame buildings are most common type of constructions in urban India, which are subjected toseveral types of forces during their lifetime, such as static forces due to dead and live loads and dynamic forcesdue to earthquake. To ensure safety against seismic forces of multi-storied building hence, there is need to studyof seismic analysis to design earthquake resistance structures. In the present study a multi-storied framedstructure is selected, And Linear seismic analysis is done for the building by static method (Equivalent StaticMethod) and dynamic method (Response Spectrum Method & Time history Method) using ETABS as perthe IS-1893-2002-Part-1. As a result, the response of structure has been obtained for considered buildingmodels, based on each method of analysis, and then the results are compared with each other.

Keywords: RC structure, seismic analysis, Equivalent Static, Response Spectrum and time history analysis, Displacement, Acceleration, base shear…

I. INTRODUCTION

An Earthquake is Earth's Shaking or in other words release of energy due to the movement of tectonic plates. This can be destructive enough to kill thousands of people and bring huge economic loss. This natural disaster has many adverse effects on earth like ground shaking, landslides; rock falls from cliffs, liquefaction, fire, tsunami etc. Buildings are highly affected by an earthquake, and in some cases, they are shattered down to the ground level. When the ground shaking occurs beneath the building's foundations, they vibrate in an analogous manner with that of the surrounding ground. The inertia force of a structure can develops shearing effect on it which in turn causes stress concentration on the connections in structure and on the fragile walls. This results in partial or full failure of structure. The excitement and prevalence of shaking depends on the orientation of the building. High rise structures have the tendency to magnify the magnitude of long-time periodic motions when comparing to the smaller one. Every construction has a resonant prevalence which are the characteristics of structure. Taller buildings have a tendency for long time periods than shorter one which make them relatively more susceptible to damage. Hence, one has to be careful while performing the analysis of a tall structure. In order to analyse a tall structure mainly three analysis procedures are valid like a) Equivalent static analysis, b) Response spectrum analysis, c) Time history analysis. Soil structure interaction analysis is also essential to be considered. After identifying the soil type analysing procedure is selected to do the detailed analysis of the interaction between soil and structure. To reduce the seismic effects on tall buildings several equipment is used like dampers or base isolation process. In dampers viscous damper, friction damper, yielding damper, magneto rheological fluid dampers tuned mass damper or harmonic absorber can be used. The main objective of this project is to study the seismic behaviour anddamage of concrete reinforced building. Also, analysis of structure by using equivalent static method, response spectrum method and time history method has been surveyed based on IS codes; The maximum storey displacements result have been obtained by using all methods of analysis and compared to displacement capacity of building to assess the damage of building.

II. SEISMIC ANALYSIS METHODS

Seismic analysis is a major tool in earthquake engineering which is used to understand the response of buildings due to seismic excitations in a simpler manner. In the past the buildings were designed just for gravity loads and seismic analysis is a recent development. It is a part of structural analysis and a part of structural design where earthquake is prevalent. There are different types of earthquake analysis methods. Some of them used in the project are

I. Equivalent Static Analysis
II. Response Spectrum Analysis
III. Time History Analysis

III. ANALYTICAL WORK

Building consists of 16m in both X direction and Y-direction for Static (Model1: Equivalent Static Analysis) and DynamicsAnalysis (Model2: Response Spectrum and Model3: Time History Analysis) on computer program ETABS to studied seismic behaviour of structure for globally considered models, so from preliminary design the sizes of various structural members were estimated as follows:

Brick masonry wall Thickness: 230mm
Storey height: 3m for all floors.
Grade of steel: Fe-500
Grade of concrete: M-25
Column Size: 450X450mm
Beam Size: 450X 450mm
Slab thickness: 150 mm
Dead Load (DL):
Intensity of wall (Ext. & Int. wall) = 13.11 KN /m
Intensity of floor finish load =1KN /m2
Intensity of roof treatment load =1KN /m2
Live load (LL):
Intensity of live load =3 KN /m2
Lateral loading (IS 1893 (Part I):2002):
Building under consideration is in Zone –V
Period Calculation: Program Calculated
Top Storey: Storey- 10
Bottom Storey: Ground Floor or Base
Response reduction factor, R = 5
Importance factor, I = 1
Building Height H = 30m
Soil Type = II (Medium Soil)
Seismic zone factor, Z = 0.36
Ground Motion Database: Matched To Response Spectrum
Time history motion type: Transient
Case: EQX and EQY
Spec X and Spec Y
THX and THY

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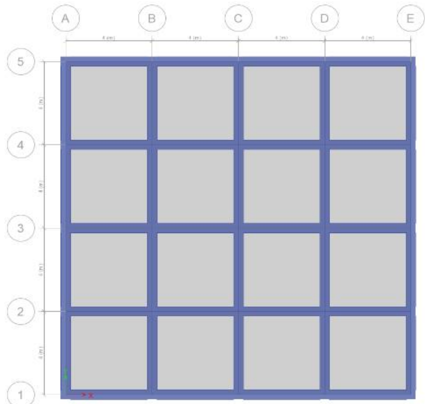


Fig.1: Plan of structure

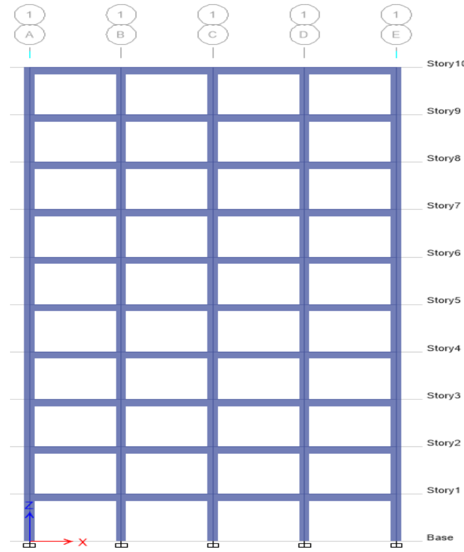


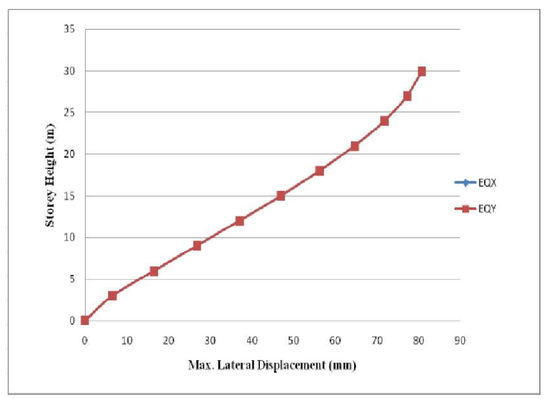
Fig 2: Elevation of Considered Structural Models

IV. RESULTS AND DISCUSSION

1) Maximum Lateral Displacement

Table1:Maximum displacement of Model 1

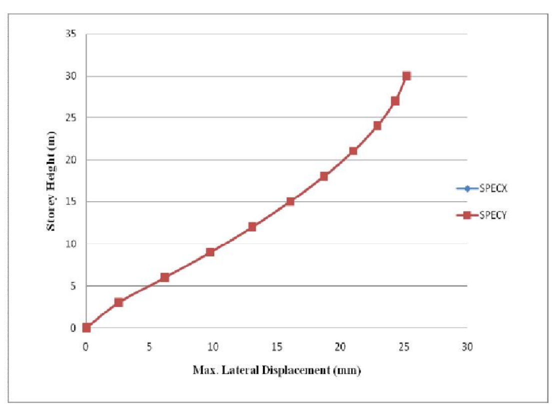
Storey No's	Storey Height (m)	EQX	EQY
Story10	30	80.804	80.804
Story9	27	77.319	77.319
Story8	24	71.85	71.85
Story7	21	64.71	64.71
Story6	18	56.302	56.302
Story5	15	46.986	46.986
Story4	12	37.078	37.078
Story3	9	26.846	26.846
Story2	6	16.541	1.65E+01
Story1	3	6.637	6.637
Base	0	0	0



Graph 1: Maximum displacement of Model1 with respect to height

Table2: Maximum displacement of Model 2

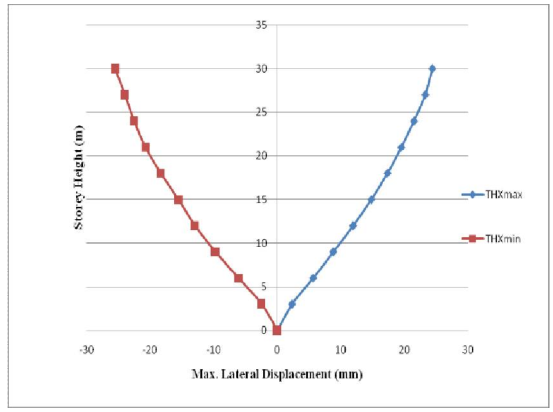
Storey No's	Storey Height (m)	SPECX	SPECY
Story10	30	25.231	25.231
Story9	27	24.327	24.327
Story8	24	22.905	22.905
Story7	21	21.011	21.011
Story6	18	18.711	18.711
Story5	15	16.052	16.052
Story4	12	13.058	13.058
Story3	9	9.753	9.753
Story2	6	6.181	6.181
Story1	3	2.533	2.533
Base	0	0	0



Graph 2: Maximum displacement of Model2 with respect to height

Table3: Maximum displacement of Model 3 (For X / Y Direction)

Storey No's	Storey Height (m)	THXmax	THXmin
Story10	30	24.373	-25.462
Story9	27	23.268	-23.931
Story8	24	21.483	-22.492
Story7	21	19.495	-20.698
Story6	18	17.313	-18.289
Story5	15	14.776	-15.516
Story4	12	11.918	-12.921
Story3	9	8.8	-9.686
Story2	6	5.632	-6.079
Story1	3	2.318	-2.457
Base	0	0	0

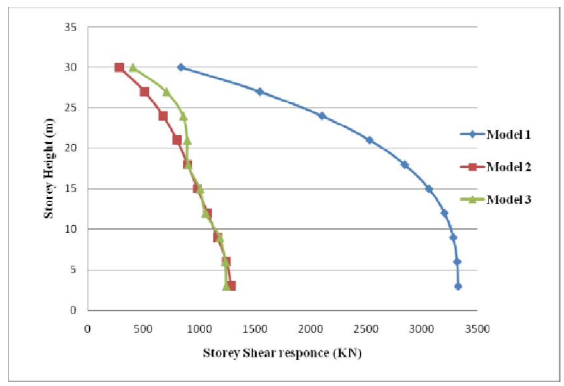


Graph 3: Maximum displacement of Model3 with respect to height

2) *Store Shear Response*

Table4: Storey shear force(KN) distribution along X-direction

Storey No's	Storey Height (m)	Model I	Model 2	Model 3
Story10	30	837.0815	281.076	402.2952
Story9	27	1544.2724	509.517	704.5752
Story8	24	2103.0405	674.577	855.6859
Story7	21	2530.8473	798.744	891.8088
Story6	18	2845.1543	895.874	900.1325
Story5	15	3063.4231	983.548	1005.546
Story4	12	3203.1152	1072.94	1056.222
Story3	9	3281.6919	1161.83	1184.224
Story2	6	3316.6149	1242.79	1234.16
Story1	3	3325.3457	1287.69	1241.807



Graph 4: Storey shear force(KN) distribution along X-direction

Table5:Storey shear force(KN) distribution along Y-direction

Storey No's	Storey Height (m)	Model I	Model 2	Model 3
Story10	30	837.0815	281.076	402.2952
Story9	27	1544.2724	509.517	704.5752
Story8	24	2103.0405	674.577	855.6859
Story7	21	2530.8473	798.744	891.8088
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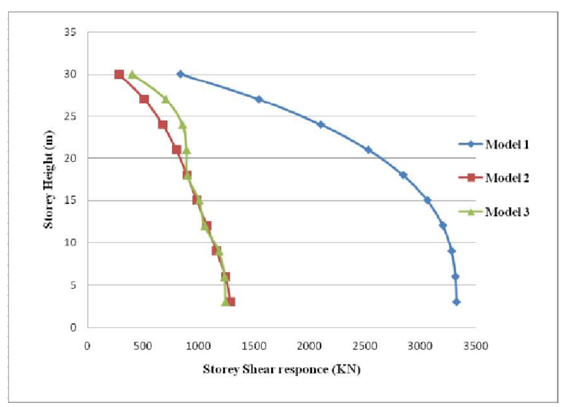

Graph 5: Storey shear force(KN) distribution along Y-direction

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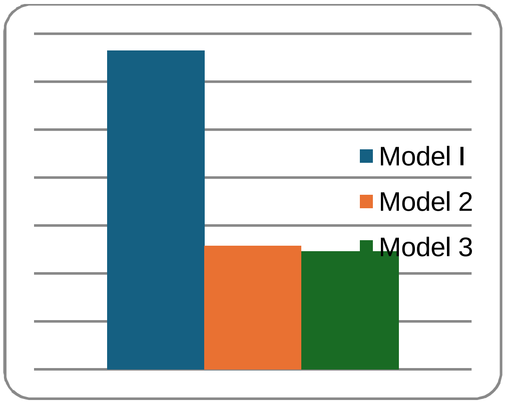
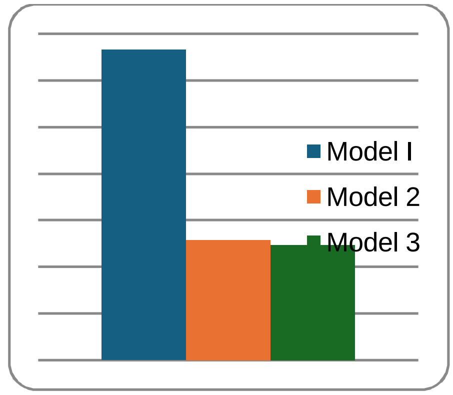
3) Base Shear

Table5.15: Comparision of Base Shear for Model1, Model2 & Model3

Model	**Analysis**	**X-direction**	**Y-direction**
Model 1	ESA	3325.3457	3325.3457
Model 2	RSA	1287.693	1287.693
Model 3	THA	1235.1789	1235.1789



Graph 6: Maximum Base Shear along X direction for all considered Models



Graph 7: Maximum Base Shear along X direction for all considered Models

V. CONCLUSION

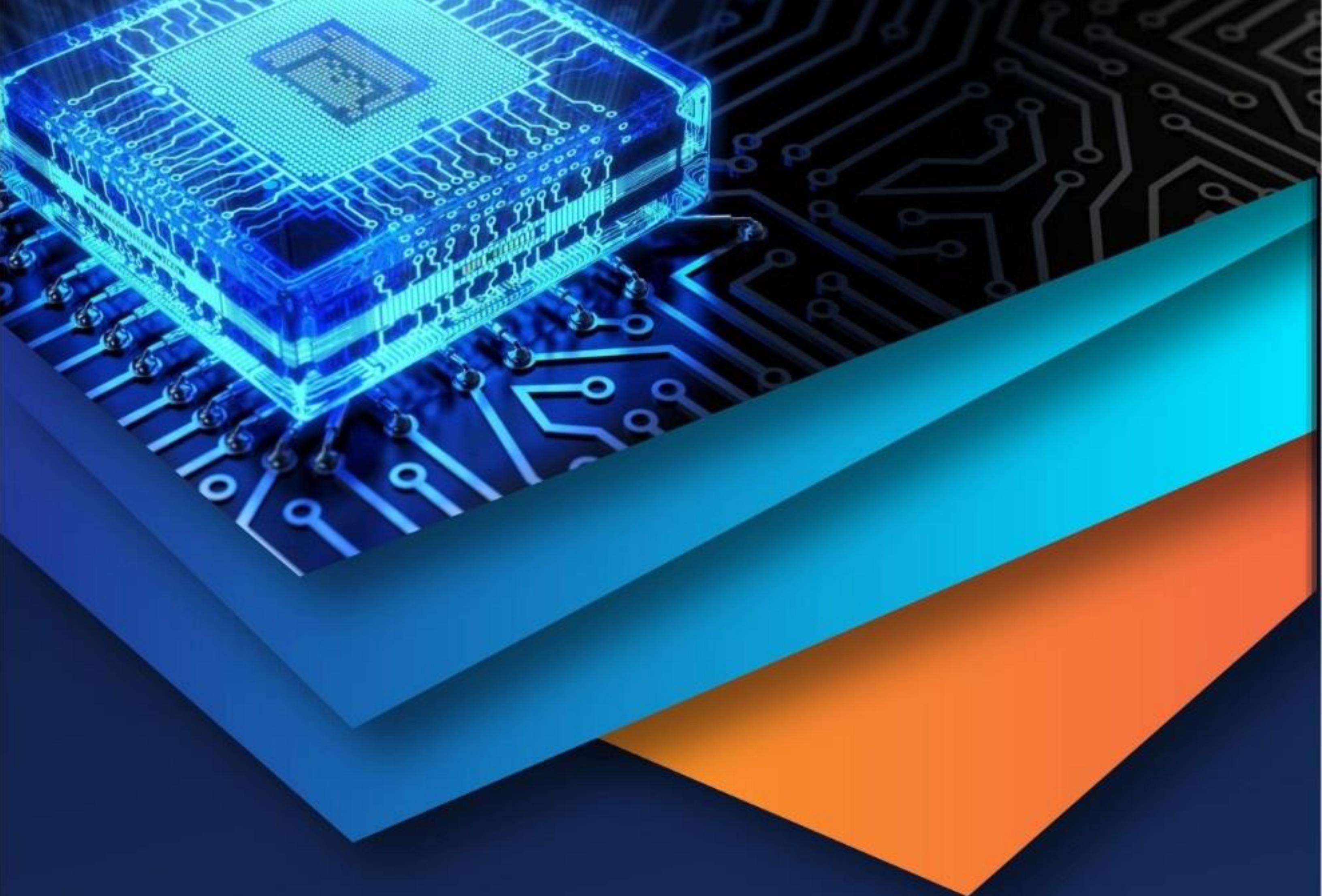
In this study, the seismic vulnerability of building is shown through an example building. The main object of this investigation is to study the effect of horizontal loading on reinforced concrete frame for three different analysis models i.e.(I) Model 1- StructureAnalyzed by Equivalent Static Analysis, (II) Model 2- Structure Analyzed by Response Spectrum Analysis and (III) Model 3- Structure Analyzed by Time History Analysis. In this section only the conclusion obtain from the analysis result and their discussions are presented. This study leads to following conclusion.

1) As a result of comparison between three mentioned analysis it is observed that the displacement obtained by static analysis are higher than dynamic analysis including response spectrum and time history analysis
2) The spectral acceleration verces period is used to define the acceleration values in the both directions, i.e. THX and THY, to account for the directional uncertainty of the earthquake motions and the low probability of simultaneous occurrence of the maximum response for each direction, the time-history method allows a much more complete analysis because it provides the time evolution of any kind of result. For important structures time history analysis should be perform as it predicts the structural response more accurately in comparison with other two methods.
3) From results and discussion chapter, Linear static analysis of structures can be used for regular structures of limited height as in this process lateral forces are calculated as per code based fundamental time period of the structure. Linear dynamic analysis are an improvement over linear static analysis, as this analysis produces the effect of the higher modes of vibration and the actual distribution of forces in the elastic range in a better way.
4) Static analysis is not sufficient for high rise building and its necessary to provide dynamic analysis. The results of equivalent static analysis are approximately uneconomical because values of displacement are higher than dynamic analysis.
5) A quantitative comparison of the base shear for three models is presented. Their seismic performance during the seismic time period interval has been vary. Although the three analysis have different attributes, they all have acceptable performance and are expected to behave desirably in seismic events.
6) Suitable methods of analysis are provided in codes of practice; in general, the more complex and taller the building, the more stringent the analysis that is required. The linear time history method has huge potential to improve seismic performance in that dynamic amplification effects due to yielding are explicitly included in the evaluation.

REFERENCES

[1] IS: 1893-2002 part-1 Code of Practice Criteria for Earthquake Resistant Design of Structures (Part 1 : General Provision and Buildings)

[2] IS: 4326-1993 Code of Practice Earthquake Resistant Design and Construction of Buildings
[3] IS: 13920-1993 Code of Practice Ductile Detailing of Reinforced Concrete Structures subjected to Seismic Forces
[4] [1] MrunmayiGursale and P.S.Patil, Comparative parametric study of linear and nonlinear behavior of multistory structures, International Journal of Research in Engineering and Technology, Volume: 04 Issue: 04 | Apr-2015
[5] Pankagagrawal, Manish shrikhande, Earthquake resistant design of structure.
[6] S.K. duggal, Earthquake resistant design of structure.
[7] Chopara A. K, Dynamic of structure
[8] IS 1893(part 1) (2002), Indian Standard Code of Practice for Criteria for Design of Earthquake Resistant Structures, Bureau of Indian Standards, New Delhi.
[9] IS 456:2000, Indian Standard Code of Practice for Criteria for Plain and Reinforcement concrete, Bureau of Indian Standards, New Delhi
[10] EERI, 1999, Earthquake Engineering, Lessons Learnt Over Time – Learning from Earthquakes Series: Volume II Innovative Recovery in India,
[11] IITK-BMTPC Earthquake Tip, New Delhi, Research Institute, Oakland (CA), USA.Murty, C.V.R., 2004.
[12] FEMA – 547. (2006). Federal emergency management Agency, "Techniques for the seismic rehabilitation of existing buildings."
[13] Washington, D.C. FIB (2003)." Seismic Assessment and retrofit of reinforced concrete buildings: state of the art report – International (4), 552- 568.
[14] IS 456 – 2016, Bureau of Indian standards, New-Delhi (2016), Code of practice for "Plain and Reinforced Concrete".
[15] IS 10262 – 2019, Bureau of Indian standards, New-Delhi (2019), Indian standard recommended guidelines for concrete mix design,
[16] ACI 440. 1R(2007). American Concrete Institute (ACI) Committee 440 Farmington Hills, MI, Report on "Fibre-Reinforced Polymer (FRP) Reinforcement",
[17] ACI 440. 2R (2008). American Concrete Institute (ACI) Committee 440.Farmington Hills, MI. Guide for the "Design and Construction of externally bonded FRP Systems",
[18] ACI 544. 1R (2002), American Concrete Institute 544. Farmington Hills, MI, State of the Art report on "Fibre Reinforced Concrete",
[19] ACI 544. 5R (2010), American Concrete Institute 544, Farmington Hills, MI. Topic on the "Physical Properties and Durability of Fibre-Reinforced concrete",
[20] Alcocer, S.M. (1993), Journal of Structural Engineering, ASCE, Vol. 119, No. 5, app. 1413 – 1431, RC Frames Connections Rehabilitated by Jacketing,"
[21] Alcocer, S.M. and Jirsa, J.O (1993). ACI Structural journal, Vol. 90, No.3, Topic on "Strength of Reinforced Concrete Frame Connections Rehabilitated by Jacketing",
[22] Austin, S; Robin, P. and Pan, Y. (1999). Cement and Concrete Research, Vol. 29, No. 7, pp. 1067- 1076. "Shear Bond Testing of Concrete Repairs",
[23] Bett, B.J; Klingner, R.E and Jirsa, J.O. (1988)."Lateral Load Response of strengthened and Repaired Reinforced Concrete Column", ACI Structural Journal, Vol. 85. 5, pp. 499-508
[24] Beushausen, H and Alexander, M.G. (2008). "Bond Strength Development Concretes of Different ages", Magazine of Concrete Research, Vol. 60, No.1, pp. 65.
[25] Seible, F; Priestly, M.J.N; Hegemier, G.A; and Innamorato, D (1997) ASCE –Journal of Composites for Construction, 1 (2), 52-62. "Seismic Retrofit of RCColumns with Continuous Carbon Fiber Jackets",
[26] Saadatmanesh H, Ehsani MR and Jin L; (1997) ACI Structural Journal 94, Studyon "Repairs of Earthquake – Damaged RC Columns with FRP Wraps",
[27] Saadatmanesh, H; and Ehsani, M.R. (1990) Journal of Structural Engineering,ASCE, 117, PP. 3417 – 3433. "Reinforced Concrete Beams Strengthened with GFRPplates I",
[28] Saadatmanesh, H; Ehsani, M.R; and Jin, L. (1996) "Seismic Strengthening ofcircular bridge pier models with fiber composite", ACI Structural Journals, 93 (6), pp.639-647.
[29] Saxena, P; Toutanji, H; and Noumowe, A. (2008) "Failures Analysis of FRP –strengthened RC Beams", Journal of composites for construction, 12 (1), pp. 2-10



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