

Effect Of Stiffness Modification Factor on Behaviour of RC Structure

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Abstract

In India most of the area are highly prone to seismic forces as when the seismic force hit the structure will cause harmful effect on RC Structure. Due to seismic force time cracks are formed on the non-structural members and so the stiffness of the member can be reduced.

The stiffness modifier concept is recently used in Indian standards (IS 1893: Part-1 2016 and IS 16700: 2017). As Stiffness the s most important property any element which shows capacity of element to resist external force and solidness of an element. In this paper we had studied different values of stiffness modifier given by different researchers and codes for serviceability limit of the structure.

The clause no. 6.4.3.1 of the code defines requirements for structural evaluation. It is mention in the clause that for structural analysis, for column 70% of the gross should be considered and for beam 35% of the gross should be considered. A detail analytical study carried out between building having stiffness modifiers and ordinary building without stiffness modifiers. The response spectrum method is good method can be applied to the models. The mode displacement is acquired by modelling the Structure in the Structure analysis software (ETAB). The main motive was to compare the modified Structure with the ordinary Structure. Parameter has help in comparison of these models. Result of displacement, drift and shear reinforcement were in very higher side when using stiffness modifiers so there is quite scope to classified stiffness modifiers value according to different

height of the structure, shape of structure and earthquake zone.

Stiffness modifiers, Response spectrum method structure analysis software ETAB seismic forces, Geometry of the structure

Introduction

Firmness of the part implies that unbending nature of the part. General term its capacity of the part to oppose distortion and diversion under the action of the apply load. In the event that the individuals have less solidness, it's turned into a great deal of adaptable. A design that that is made from numerous different construction parts comprised of a wide range of underlying components, those parts can convey load proportionate to their general firmness Therefore the heap a component will draw in builds the stiffer it is. Seismic powers which are producing during tremor vigorously influence built up substantial segment, for example, structures, spans and so on.

firmness modifiers in etabs are the variables to increment or abatement a couple of homes of the cross segment for instance region, latency, torsional steady, etc. usually, they might be utilized to decrease firmness of substantial segments to show for broke conduct of cement. They are simply applied to substantial individuals since it breaks under stacking

For direct examination of individuals, part firmness' control gauges of the time of the construction, the heaps are conveyed inside the

design. For nonlinear investigation, we get an exact gauge of the partner firmness that was expected to appraise the yield dislodging, which thus, influences an interpretation pliability nervousness. In Real-world, precise methodology are expected to assess the viable solidness up to yielding of each underlying part.

plan of areas is finished essentially based at the powers determined from examination of the shape. Those powers depend on firmness of the benefactors. firmness is the possibility to draw second, shear, hub pressure and numerous others. stiffer a component, more strain it draws and additional support we format for. In a structure a few components are stiffer, and others are less solid. along these lines, they draw in unique measures of powers depending upon their firmness. Applied stacking on a structure produces interior powers. These internals powers, for example, flexure, shear, twist and hub powers bring about pressure or strain in substantial filaments. concrete is solid in pressure anyway it is best appropriate in strain as little as roughly 10% of its compressive strength. At this breaking point, substantial breaks, decreases in region and firmness. it's miles no longer to be needed to look up to tractable developments. As the firmness lessens so does the second drawing in capacity. some existing apart from everything else which changed into present at this part (for instance at radiates) goes to various areas which are not yet broken (as an example segments). The reshuffling of the firmness in the entire construction prompts rearrangement of minutes. in this way, those un broke regions (as a case segments) should be intended for more second than what they truly acquired before second reallocation. This peculiarity is known as rearrangement of minutes. those regions which were un broken and gotten additional minutes from broke regions might break when the substantial in that locale arrives at its ductile ability limit. Thus, this pattern of second rearrangement go on until all the part have been broken. Steel support which sits inactive before this stage currently begin taking those of the rearranged second.

seismic homes are configuration has ordinarily been founded on results from conventional direct assessment procedures. this state of investigation is an undertaking for the design of built up concrete because of the reality the material is composite and demonstrates nonlinear way of behaving of this is directed via the perplexing collaborations among its added substances the supporting metal and the substantial lattice. Improving on the way of behaving of built up substantial added substances, all together that they might be demonstrated the utilization of a direct versatile assessment procedure, is significant to our ability to effectively format reinforced substantial frameworks.

Objects of Study

To do comparative studies on analysis of structure model with stiffness modifiers and structure, model of without stiffness modifiers for the different earthquake zone up to the building height of sixty-six m.

To study the behaviour of R.C.C, structure components like beam and column underneath the impact of stiffness, reduction factors as per IS 1893(2016) part-1 are considered in to account of different shape of the building including square shape building, rectangular shape building.

To perceive the comparison of RCC structure displacement, RCC structure drift, fundamental time period, area of the shear, reinforcement axial force in column, span moment and ends moment in beam for model with stiffness modifiers and model without stiffness modifiers

Scope of the Work

3D modelling and analysis will be carried out on the structure model with differ floors plan such that square floor plan, rectangular floor plan and shape floor plan. Each model prepared with stiffness modifiers and without stiffness modifiers.

Total ten no. of model, will be analysed of varying height sixty-six metre. The identical model of Various earthquake zone II, III, IV and V ought to be through-about for the analysis of structure.

3D modelling and, analysis ought to be done by ETAB (2019) package.

Methodology of analysis: Response spectrum methodology

Formula and values for numerous parameters are be taken from the IS 1893(2016) part-1.

Parameter ought to be studied,

Modal Results

Comparison of displacement

storey drift

Amounts of Column reinforcement

Time amount for numerous mode

Span moment of beam.

Storey Shear.

Analysis Results and Review of Structural elements

Modal Analysis

The modal analysis of the building is presented in table below. As per the analysis result, principal mode of oscillation is torsion in first mode. Second and third mode of oscillation are mixed mode with significant amount of torsion mode.

Drift Analysis

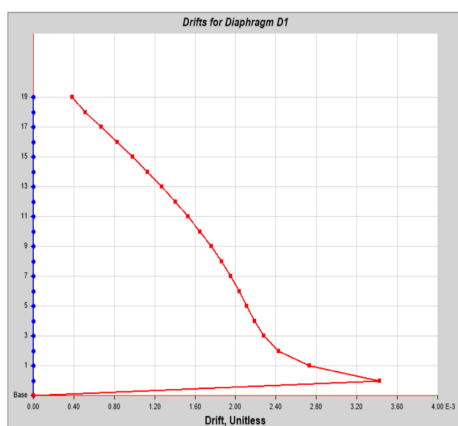
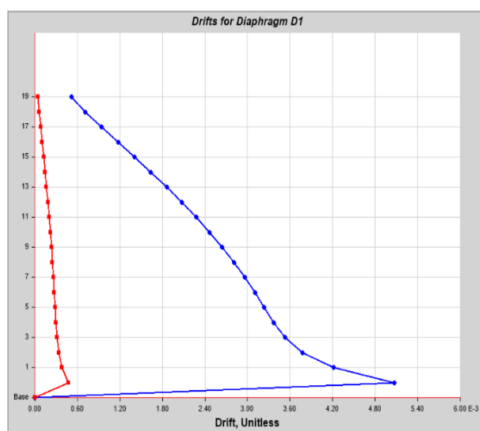
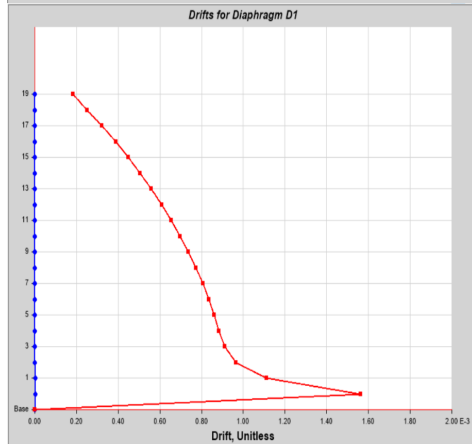
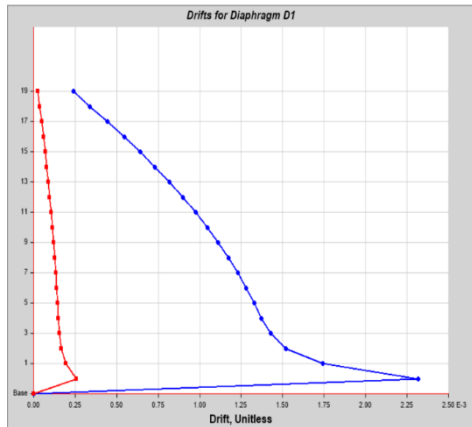
Story Drift is characterized as the distinction in horizontal redirection between two nearby stories. Horizontal redirection and drift thereby affect a design; the development can influence the underlying components (like pillars and sections); the developments can influence non-primary components (like the windows and cladding), and the developments can influence adjoining structures. Without legitimate

thought during the plan cycle, huge diversions and Drifts can unfavourably affect underlying components, non-primary components, and adjoining structures. Drift issue as the flat uprooting of all tall structures is one of the most major issues in tall structure configuration, connecting with the powerful qualities of the structure durs because of wind or seismic stacking should be considered for tall structure plan alongside gravity powers vertical burdens. Tall and slim blast emphatically short of breath wind touchy and wind powers are applied to the uncovered surfaces of the structure, while seismic powers are inertial (body powers), which result from the twisting of the ground and the inertial obstruction of the structure.

1. The bigger the Drift, the less firm the construction is. Assuming the Drift is more noteworthy on the X-bearing than that of the Y-course, the Y heading might be stiffer. Furthermore, in that capacity, you can begin to follow whether this ought to truly be the situation by checking the underlying plans out. In the event that it says something else, you should do a nitty gritty check.

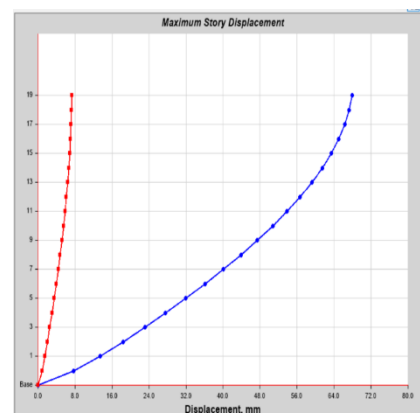
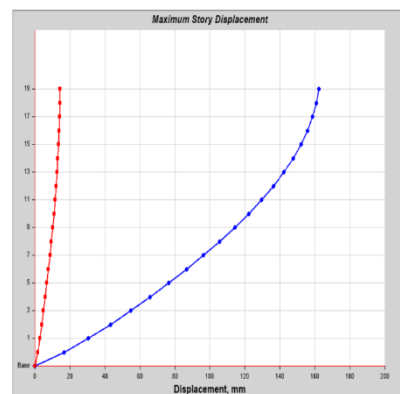
2. You can see which explicit floors require "fortifying" or which floor requires reinforcing the solidness. Does the rooftop influence like there's no tomorrow? It's totally conceivable on the off chance that the rooftop region is not exactly the story beneath it. Does it influence unreasonably on the primary level? On the off chance that you have a multi-story structure, you should add shear dividers or horizontal bracings to address it. On the diagram over, the breeze Drift on the thirteenth floor is exorbitant as this is the outlining of the helipad walkway and it is comprised of a steel outlining.

3. Serviceability is a fundamental prerequisite that intends to restrict the story Drift. Is the subsequent Drift inside as far as possible? In the event that not, then you should add a couple of stiffener dividers assuming the engineers license or perhaps recommend another outlining that will work.



Displacement Analysis

The urban centralization is causing suffocation of place for the survival of people in the urban areas, hence to fix this issue and to avoid the creation of slums; vertical living is applied in many metropolitan cities. The construction of these high-rise structures is a difficult task for the engineers as it has many criteria's such as lateral forces, soil condition, strength of the structure, stiffness of the structure, economical etc. Nowadays in the construction of the high-rise buildings there are many advancements implemented, one of the latest advancements is Shear wall. It is a vertical element which withstands the lateral forces for shear and bending. Shear wall is designed as shell type, shell elements have both bending as well as in-plane stiffness which can resist moments and forces from all direction. Shear wall can withstand lateral forces (Wind and earthquake effect) to a greater extent.



Conclusion

The critical conclusions which may be derived from this research work are as observe: -

- Displacement of the structure, after the software of stiffness modifiers to the shape element become improved by means of round 40% of all type of constructing shape like square shape, square shape constructing.
- A shape version with stiffness discount modifiers has a 50% higher storey waft price than regular structure model. And from the graphs we concluded that go with the flow fee of the square building is comparatively above the rectangular building and C-shape(irregular) building.
- due to software of stiffness modifiers to the structure detail like beam and column, typical stiffness of the structure was reduced because after the application of stiffness modifiers herbal fundamental length was improved around 30% in comparison to shape model without having any stiffness modifiers. herbal time period become additionally multiplied with height of the structure.
- For the rectangular ground plan building, while the stiffness of the beam and column are decreased as per IS 1893-part 1(2016), shear capability of building is reduced round 15-25% which might also depend on the building peak and beam-column form and their region. For rectangular building shear capacity of build up to peak 15m, 30m and 45m become decreased by approximately 15%, 20% and 23% respectively.
- In case of rectangular, or irregular ground plan, after the software of stiffness modifiers to structural contributors, shear potential of building is decreased around 30- 40% and during designing of this member, required amount of shear reinforcement is better than the codal permissible cost so it noticed over pressured member in ETAB. So waned to boom go section region of the structural member which ends up in boom normal price of the shape.
- below the analysis of factored load mixture, Span moment of structure with stiffness modifiers become reduced by 15 to 30%. For the square and square structure, span second

became reduced with the aid of 25 and 28percentrespectively

- From this study we conclude that, the most resistant floor plan become the square floor plan after the utility of stiffness modifiers. We understand that, price of displacement and glide of the square plan have been immoderate than permissible price however we can reduce or triumph over this impact through replacing stiffness modifiers value for beam is 0.5 instead of 0.35 that's given in IS 1893-part 1 (2016). We also can lessen displacement and drift by way of supplying square column in reciprocal route.
- The price of stiffness modifiers for beam and column given in IS 1893-component 1(2016), have to be classified in keeping with unique height, shape of the shape and earthquake area in place of single price.

References

1. IS 1893-Part-1(2016), "Criteria for earthquake resistance design of structure part 1 general provision and building", Bureau of Indian Standards,6th revision,2016.
2. IS 456-2000 "Plain and reinforced concrete code of practice", Bureau of Indian Standards,4th revision,2000.
3. Tom Paulay," Re-definition of the reinforced concrete element and its implication in seismic design, "Structural Engineering International Vol. 1(2001)
4. Bhavin shah, <http://www.linkedin.com/pules/stiffness-modifiers-per-1893-part-1-2016-bhavin-shah>
5. Philip C.Perdikaris said Hilmy,"Extensional Stiffness of precracked R/C panel.
6. John-Michal Wong "effective stiffness for modelling reinforced concrete structure.
7. R. Pique, M. Burgos, "The 14th World Conference on Earthquake Engineering" (2008).
8. Pengfei Luo, Dongjian Shen, Haijie Mi, Xiangya Kong, Jianxin Wang, "Stiffness Reduction Factor of Reinforced Concrete Bridge Pier Considering Characters of

- Nonlinear”, Critical Issues in Transportation Systems Planning, Development, and Management (2009), pp. 2482-2490.
9. Taehyo Park, Myung-Hyun Noh, Sang-Youl Lee, George Z. Voyiadjis, “Identification of a distribution of stiffness reduction in reinforced concrete slab bridges subjected to moving loads”, Journal of Bridge Engineering, Vol. 14, No. 5 (2009), pp. 355-365.
 10. Jinqun Zhong, Paolo Gardoni, David Rosowsky, “Stiffness degradation and time to cracking of cover concrete in reinforced concrete structures subject to corrosion”, Journal of Engineering Mechanics Vol. 136, No. 2 (2010), pp. 209-219.
 11. Bing Li, Weicheng Xiang, “Effective stiffness of squat structural walls”, Journal of Structural Engineering, Vol. 137, No. 12 (2011), pp. 1470-1479.
 12. J.L. Bonet, M.L. Romero, P.F. Miguel, “Effective flexural stiffness of slender reinforced concrete columns under axial forces and biaxial bending”, Engineering Structures Vol. 33 (2011), pp. 881–893.
 13. Damir Vidovic, Davor Grandic, Paulo Sculac, “Effective stiffness for structural analysis of buildings in earthquake”, 4th international conference civil engineering - science and practice, (2012), pp. 811-818.
 14. Bing Li, “Initial stiffness of reinforced concrete columns and walls”, 15th World Conference on Earthquake Engineering, Vol. 1 (2012), pp. 94-103.
 15. Arnaud Castel, Thierry Vidal, Raoul Francois, “Finite element modelling to calculate the overall stiffness of cracked reinforced concrete beams”, Journal of Structural Engineering, Vol. 138, No. 7 (2012) pp. 889- 898. Jianfei Liu, Yanjun Zhang, Pengfei Luo, “Flexural stiffness reduction factor of reinforced concrete column with equal I shaped section”, The Twelfth COTA International Conference of Transportation Professionals, (2012), pp.3187-3193.
 16. Mehmed Causevic, Tomislav Frankovic, Nino Mahmutovic, “Effects of stiffness reduction on seismic capacity of buildings”, Gradevinar, Vol.6 (2012), pp.463- 474.
 17. T.O. Tang and R.K.L. Su, “Shear and flexural stiffnesses of reinforced concrete shear walls subjected to cyclic loading”, The Open Construction and Building Technology Journal, 2014, Vol. 8 (2014), pp. 104-121.
 18. Arnaud Castel, Raymond Ian Gilbert, Gianluca Ranzi, “Instantaneous stiffness of cracked reinforced concrete including steel-concrete interface damage and long-term effects”, Journal of Structural Engineering, Vol.140 (2014), pp. 1-9.
 19. Sourav Das, Satyabrata Choudhury, “Influence of effective stiffness on the performance of RC frame buildings designed using displacement-based method and evaluation of column effective stiffness using ANN”, Engineering Structures, Vol. 197 (2019), pp. 1-21.
 20. IS 13920-2016, “Ductile Design and Detailing of Reinforced Concrete Structures Subjected to Seismic Forces- Code of Practice”, Bureau of Indian Standards, 1st revision, 2016.
 21. IS 16700-2017, “Criteria for Structural Safety of Tall Buildings”, Bureau of Indian Standards, 2017.
 22. ACI 318-19, “Building Code Requirements for Structural Concrete”, American Concrete Institute, 2019.
 23. FEMA 356 “Pre-standard and Commentary for the Seismic Rehabilitation of Buildings”, American Society of Civil Engineer, 2000.
 24. TEC 2007, “Turkish Earthquake code”, 2007. [27] UBC 1997,” Structural Engineering design provision” Uniform Building Code Vol 2,1997. [28] NZS3101.2.2006, “Concrete structure Standard part-2 commentary on design of concrete structure”, New Zealand Standard, 2006.
 25. A.M. Mwafy, N. Hussain & K. El-Sawy, “seismic assessment and cost-effectiveness of high-rise buildings with increasing concrete strengths”
 26. Jaimin Dodiya, Mayank Devani, Akash Dobariya, Mehul Bhuva, Kamalsinh Padhiar, “analysis of multistory building with shear wall using etabs software”
 27. Dr. K. Chandrasekhar Reddy, G. Lalith Kumar, “Seismic Analysis of High-Rise Buildings (G+30) by Using ETABS”
 28. A.Pavan Kumar Reddy, R.Master Praveen Kumar, “Analysis of G+30 Highrise

Buildings by Using Etabs for Various
Frame Sections In Zone IV and ZoneV”

29. Ali Kadhim Sallal, “Design and analysis
ten storied building using ETABS
software-2019 “
30. Rinkesh R Bhandarkar ,Utsav M
Ratanpara, Mohammed Qureshi, “Seismic
Analysis & Design of Multistory Building
Using Etabs”
31. Mahesh N. Patil, YogeshN.
Sonawane,“Seismic Analysis of
Multistoried Building”
32. Ravikanth Chittiprolu, Ramancharla
Pradeep Kumar, “Significance of Shear
Wall in Highrise Irregular Buildings”.