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Construction Sequential Analysis and Design of Rc High Rise Buildings by Etabs

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ABSTRACT:-

Building structures are analyzed in a single step using linear static analysis on the assumption that the structures are subjected to full load once the whole structure is constructed completely. In reality the dead load due to the each structural components and finishing items are imposed in separate stages as the structures are constructed story by story for nonlinear behavior of materials. Advancement of finite element modeling accelerates the accuracy of finite element simulation by taking the consideration of construction sequential effects. In this paper, rigid frame structures of both concrete and steel model of different configurations have been taken for sequential analysis. The analysis outcomes will help to understand how the structural response against loads varies for construction sequential analysis and linear static analysis while highlighting the material property. For vivid understanding of necessity of sequential analysis, analysis outcomes are eventually compared with conventional one step analysis. The effect of sequence of construction due to the self-weight of members has been studied and its effect on the overall design forces has also been highlighted using finite element modeling.

INTRODUCTION

Generally engineers, researcher and decision makers have determined the behavior of structures using linear static elastic finite element analysis including summations of vertical column loads. While building height increases in construction phase, the structural responses, i.e. axial loads, bending moments and displacements, of such typical analysis may increasingly diverge from actual behavior. Time-dependent, long- term, deformations in response to construction sequence can cause redistribution of responses that would not be computed and considered by conventional methods. This analysis was complex in nature and so many parameters have to be taken into account during analysis. But now advancement of finite element modeling and simulation has made nonlinear analysis easy, well managed and popular among engineers, researchers and decision makers which accelerate proper design of structures especially high -rise. Construction sequential analysis is becoming an essential part during analysis as many well recognized analysis software included this facility in their analysis and design package. However this nonlinear static analysis is not so popular because of lack of knowledge about its necessity and scope. Like so many other analysis, construction sequential analysis have specific purposes in design phase of the structures. As it is mentioned earlier, it deals with nonlinear behavior under static loads in the form of sequential load increment and its effects on structure considering the structural members are started to react against load prior of completing the whole structure. For finite element analysis one of the leading analysis software "ETABS (Extended 3D analysis of building systems) Version
9.7.2" is used and all displacement outcomes are measured in mm while moment and axial load are measured in kip-ft and kip respectively

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METHODOLOGY :

The strength, stability and deflection checks in the conventional design which consider linear static analysis are based on the whole structure not considering the sequential process. In reality, the behaviour of the components or units in the erection process is different from the ideal case because instability and excessive deflection occur in the construction stage with limited propping. Furthermore, shortening and undesirable deformations of the incomplete structure under self-weight and construction loads are inevitable. The structural self-weight, external loads, boundary conditions and materials are depended on stages during the construction process and their variations are overlooked in conventional design which is nothing but a limitation of conventional design procedure. Grouping of each story is considered during analysis so that software can identify its total steps required for completing the procedure. Step by step analysis, considering nonlinear behavior of materials from previous step, ensures that the construction sequence effects are properly represented in the study. Recording and investigating the variation of responses, of a particular point from starting step of sequential analysis to the last one, exhibit how construction sequence has a well impact over the design of the structures. Afterward the comparison between the findings of construction sequential analysis and linear static analysis will explain the importance of considering sequential effects during design and eventually meet the objectives of this study.

DESCRIPTION OF CONSTRUCTION SEQUENTIAL ANALYSIS

In short, linear static analysis is performed in one step while construction sequential analysis is performed in a manner, after each story construction like the real condition Figure 2. A comprehensive sequential analysis involves some essential steps which are not generally performed during linear static analysis. In order to get the sequential effects manually using software, each story should be analyzed with its prior stories assigning the vertical and lateral loads till that floor from bottom of whole structure. Eventually outcomes will represent the structural response of building till that floor. Once each story follows the same procedure the complete sequential effects could be visualized. Now-a-days analysis software are sufficiently developed to auto perform the sequential analysis easily. In this procedure, after assigning vertical and lateral loads each story is grouped to command the software to perform the analysis till that particular floor from bottom while avoiding higher story than that floor. After grouping the software eventually ask for which facility should be taken and then the outcomes could be comparing among different conditions.

FINITE ELEMENT MODELS FOR ANALYSIS

To observe the effects of nonlinear static analysis over linear static analysis finite element are formed using ETABS 9.7.2 where construction simulation analysis is included along with linear static analysis. To meet the objective, all loads and sections for both two material cases and two separate analysis procedure, are designed and taken carefully. A little divergence from actual style may leads to in appropriate modeling which cannot reflect the real situation. The time-dependent effects of creep, shrinkage, the variation of concrete stiffness with time, sequential loading and foundation settlement were accounted for by analyzing 12 separate three-dimensional finite-element analysis models, each representing a discrete time during construction on which six represent the sequential analysis while remaining six represent the linear static analysis. At each point in time, for each model, only the increasing loads occurring in that specific time-step were applied. The structural responses occurring at each time-step were accounted and added in a database to allow studying the predicted time-dependent response of the structure. To develop construction sequential effects in rigid joint structure six different story cases is taken where story variation starts from story 5 to story 30, boundary limit of rigid joint frame system. Making 5 story intervals from each makes a gradual but less time consuming analysis procedure as well.

RESEARCH CASES:

Research objectives could be met by taking consideration of construction sequential analysis along with linear static analysis for structures of different story configuration of the selected materials: RCC and Steel Table II. In this study the effects of material, story variation and analysis will be visible to the researchers, engineers as well as the decision makers. Now to make the sequential effects governing in the structures, story cases are varied from story 5 to story 30 in an interval of 5 stories which eventually generates six story cases. For easy understanding P-Delta effects is assigned in analysis procedure

RESEARCH FINDINGS

This paper presented the effects of chronological construction sequence of reinforced concrete and steel building with respect to linear static analysis. In the sequential analysis P-Delta effects of structure, shrinkage, creep and stress- strain behavior was reflected as results was quite different from outcomes of linear static analysis and this variation has tendency to decrement with the height. For comprehensive understanding of effects the finding could be categories in displacements, axial and moment. Each of those structural responses has a changing tendency with the change of analysis procedure and material.

At first, how the evaluation takes place under construction sequential analysis is elaborated for easy understanding of how the imaginary study model have acted, in such way which represent real facts happen during construction. For this part of study, the model of only story 5 is used for short presentation and with the increment of story the effects will cumulatively added to the basic analysis which will eventually leads to more severe cases. Other research results are summarized into maximum vertical displacement in the hanging column, maximum axial load into column and moment in critical beam on which the column is hanging for describing the severity of the situation and the story moment of story 30 to describe how moment changes with construction of each new story against the linear static analysis. Outcomes of the research also represent the preference and suitability of material against construction sequential effects which is steel has displacement during analysis.

ESTIMATION

An estimate is necessary to give the owner a reasonably accurate idea of the cost to help him decide whether the work can be undertaken as proposed or needs to be curtailed or abandoned, depending upon the availability of funds and prospective direct and indirect benefits. For government works proper sanction has to be obtained for allocating the required amount. Works are often let out on a lump sum basis, in which case the Estimator must be in a position to know exactly how much expenditure he is going to incur on them

CONCLUSION

My Project work at DESIGN TREE consultants has been an eye-opening as well as an enriching experience for me. Gained an in-depth and thorough knowledge on the Structural Engineering Practices exercised by Engineers in India. It is important that a prospective engineer such as me develop a strong understanding in the basics of structural element design and felt that this objective was reached throughout the project work period.

Finally concluded that, for this Spencer site micro piling and soil nailing required, because of other buildings are surrounded by this building. And raft foundation is designed by for this building using SAFE.

The study reveals the necessity of performing nonlinear static analysis becomes important with increasing slenderness while the each additional floor creates a significant load upon the columns. With increasing slenderness the necessity to perform sequential analysis considering P-Delta effects, material characteristics and nonlinear of behavior of the structures become a significant issue. Construction sequence analysis in structures of both Steel and RCC is necessary to improve the analysis accuracy in terms of displacement, axial, moment and shear force in supporting beam and column near of it and also for the whole the structure overall. Moments and shear in supporting beam are higher in sequential analysis which must be considered during manual or computer aided design in the design phase for avoiding cracking of beam and column due to sequence effects. Given analysis, design and detailing of that building. And compared the results of linear static analysis and construction sequential analysis. And finally concluded that the construction sequential analysis results are given the good results for the high-rise building.

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