Resincap Journal of Science and Engineering
Volume 3, Issue 9 September 2019
ISSN: 2456-9976

Literature Review on Chronological Sequence & Conventional Analysis.

Mr. Mohammad Afifuddin N.
P.G. Student
Department of Civil Engineering,
Shreeyash College of Engineering,
Aurangabad
afif.btc@gmail.com

Prof.A.B.Vawhale
Asst Professor
Department of Civil Engineering,
Shreeyash College of Engineering,
Aurangabad
avawhale@yahoo.in

Prof. N.S. Vaidkar
Asst Professor
Department of Civil Engineering,
Shreeyash College of Engineering,
Aurangabad
nitinvaidkar@gmail.com

ABSTRACT

While analyzing a Structural frame, conventionally all the probable loads are applied after modeling the entire building frame. 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. Accordingly, the stability of structural frame differs at every stage of construction. Even during construction freshly constructed slab with material is supported by previously cast floor by its false work. Thus, the loads assumed in conventional analysis will vary in different situation. Definitely the results obtained by the conventional analysis will be unsuitable. Therefore, the frame should be analyzed at every stage of construction taking into account variation in loads. Thus the phenomenon known as Chronological construction sequence Analysis helps to rectify this problem. This paper analyzes several numbers of multi-storey RC building frames having different bay width and length, storey height and number of stories using STAAD pro, followed by the Chronological construction sequence Analysis of each model. Also all frames models are analyzed for earthquake forces in Zone - II (IS 1893:2002) by Chronological construction sequence Analysis. Finally, a comparative study of Axial forces, Bending moments, Shear forces and Twisting moments will be done at every storey for full frame model (With & without earthquake forces) and Chronological construction sequence model (with & without earthquake forces) were compared for knowing the significance of any one of them.

General Terms

Chronological construction sequence Analysis, Conventional/ Conventional analysis, Construction loads, Sequential gravity loads

1. INTRODUCTION

Structural failure frequently occurs during the process of construction. Structure is most liable to failure during construction. Structural failures involving components or partially completed structures often occur during the process of construction. A failure during construction may not the only reason of construction error. It may be the result of an error made during design. Structural Engineers must take efforts to reduce the potential for structural failure during the construction phase to reduce the risk of injury, costs and delays.

Most of the structural failures are occurred due to lack of stability. The designer considers the structure as a completed assembly, with all elements are ready to resist the loads. Stability of the completed structure depends on the presence of all structural members, including floors. The configuration of incomplete structure is constantly changing during the process of construction and stability often relies on temporary bracing. Construction sequencing is extremely important for determining the stability of incomplete under constructed structures. Another cause of structural failures during construction is excessive construction loading which are not considered in conventional method of design and hence the loads applied to structural members while construction, are in excess of service loads anticipated by the designer. This is due to fresh floors are supported by previously cast floors by the false work system. This is the big challenge for engineers to do Analysis of the stability requirements for these incomplete, irregular, and constantly changing assemblies. To ensure stability at all times, account shall be taken of probable variations in loads during step by step construction, repair or other temporary measures. The 'Chronological Construction Sequence Analysis' that reflects the fact of the sequential application of construction loads during level-by-level construction of multistorey buildings can provide more reliable results and hence the method should be adopted in usual practice.

2. RESEARCH WORK OF DIFFERENT LITERATURES

Kenneth L. Carper [1] Draws attention towards the structural failures during construction Structural failures involving components, assemblies or partially completed structures often occur during the process of construction. An overview is presented on the factors contributing to the frequencies of these occurrences and to the vulnerability of the structures during the construction phase.

One recurring cause of structural failures during construction is excessive construction loading. Often the loads applied to structural members while construction is taking place are in excess of service loads anticipated by the designer. Construction loads may include transportation and erection loads in the case of prefabricated components. Failure to consider these loads may be a design error, if proper erection procedures are followed. Other construction loads are beyond the capacity of the designer to predict. These must be carefully monitored by the construction superintendent.

They conclude The emphasis on inspection is also encouraging. Experiments with self inspection by the contractor have not been generally successful. Quality and safety are improved when the designer is involved or represented in on-site inspection. A representative of the design firm is most qualified to interpret initial performance of the structure, to check for conformance with design intent, and to verify field conditions.

Xila Liu et.al. [2] Worked on the concept of Chronological Construction sequence analysis. The objective of this paper is to develop a three-dimensional computer model which can be used to evaluate the effect of variations of the foundation rigidity, column axial stiffness, slab aspect ratio, and shore stiffness distribution on the values of the shore loads and slab moments. The paper concludes that Variations of the foundation rigidity affect slab displacements more than the maximum shore loads and slab moments. When the rigidity of foundation decreases, the maximum slab moments and the maximum shore loads decrease

Hassan Saffarini [3] The authors apply a realistic model for the analysis of multistory frames under gravity loads. Instantaneous application of the gravity load on the complete frame can lead to significant errors. The overestimation of axial shortening in upper stories' columns is one such example. Another example of the shortcomings of ordinary frame analysis is the false simulation of load distribution in multistory frames with transfer girders in which the girder is assisted in carrying its own weight and other gravity loads by a deep vierandeel girder composed of members of upper stories that are not present at the time of the application of the gravity load. In the paper an approximation is made in which only the axial forces of the columns are transferred to previously constructed floors. This underestimates the importance of moments. Another drawback in the algorithm is that the solution of the equations has to be carried out as many times as there are stories in the frame, or else another approximation is introduced. This is to assume that a number of stories are instantaneously loaded as one substructure.
The effects of other loads, such as live loads and lateral loads, are also obtained separately by the usual structural analysis and their effects are combined with that of the gravity loads to obtain the total behavior of the structure. The algorithm proposed by Saffarini in his discussion seems to be interesting and deserves attention. The nature of the problem identified

H.M.Lee[4] Theoretically validated the concept of chronological construction sequence analysis. A new method for calculating stress and strain distributions in the structural system at every construction step including the creep effect is developed. The general validity of the approach has been demonstrated by comparisons with computed shore loads, slab moment, and displacements using the present and conventional methods of analysis. A continuous method is presented. In this method, a complete variation of interforces or displacements in a reinforced concrete structure during construction can be calculated. The general validity of the approach has been demonstrated by comparisons with computed shore loads, slab moment, and displacements using the present and conventional methods of analysis. Some essential practical upper limits and possible extensions are made to the method, widening its scope of applications.

Chang-koon choi et.al. [5] The effect of the sequential application of dead load due to the sequential nature of construction is an important factor to be considered in the multistory frame analysis. Unfortunately, however, this effect has been ignored by many engineers in practice in the past. One of the ways to include this effect properly in the analysis is to carry out the analysis through step-by-step procedures in accordance with the sequential application of dead loads as the construction proceeds. These procedures, however, require elaborated computations and more solution time. A simplified approach, termed as correction factor method (CFM), to solve the problem without elaborated step-by-step analyses has been proposed in this paper. This method utilizes the correction factors established by regression from the data obtained from the existing buildings to modify the results from the ordinary analysis to produce more accurate solutions. Some numerical tests are presented to show the validity and effectiveness of the method.

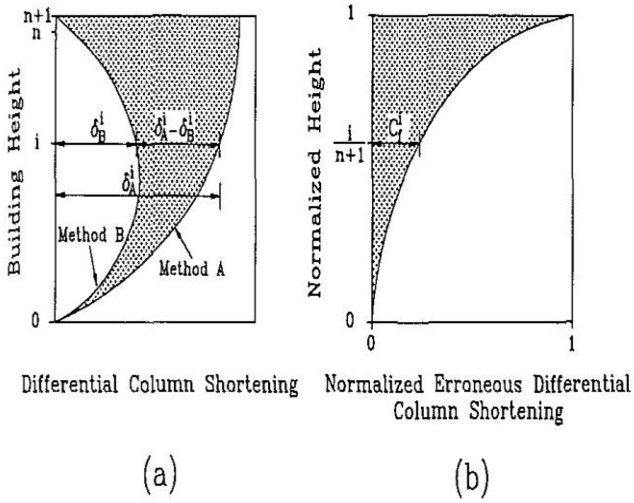

Fig.No.1. Calculation of Correction Factor

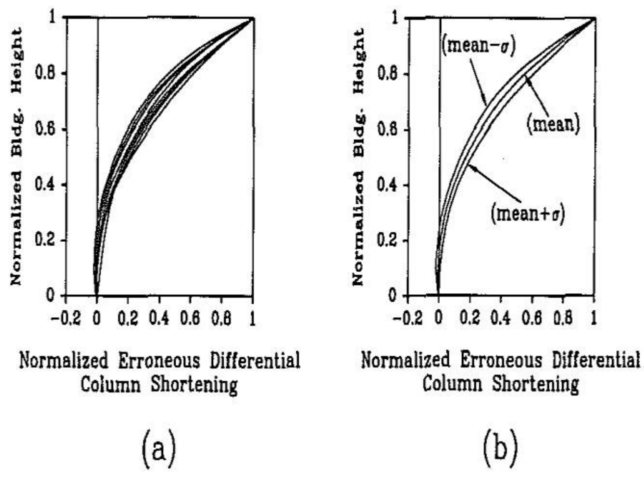

Fig.No.2. Regression of Erroneous Differential Column Shortening

Basher Alamin [6] analyzed the construction load on concrete formwork. This study presents analytical procedures for determining the loads on the shoring system and supportïng slabs during the construction of multistory concrete buildings and for determining the lateral pressures imposed by fresh concrete against the walI faces. The procedures assume two-dimensional frame models. which employ both the analysis cornputer program (CPF) and the maturity-based model. The interaction of structure and compressible shoring, rime-dependent concrete properties of strength, creep and shrinkage of concrete and the change in construction load during construction cycles are considered in the shoring system analysis. For wall fomwork analysis, the timedependent concrete properties of strength and the properties of wall-element parts are considered.

The analytical results obtained by both the shoring system and the wall formwork analyses are checked against the field measurements and several existing methods. Various parameters that affect the construction load distribution among shores and reshores and interconnected slabs, and the fresh concrete pressure distribution on wall fomwork are investigated

Hassan S. Saffarini [7] discussed the issue of variability in the results of structural analysis in common practice. Discussion is confined to reinforced concrete (RC) buildings. The sources of variability are classified into geometric simplification, material modeling, level of sophistication of analysis, and human error. These are discussed using results from the literature and from illustrative examples. Emphasis is made on the need to incorporate uncertainty of structural analysis in the development of load factors. The LRFD approach is reviewed as it relates to this problem. Studies on human error in structural design are reviewed where correlation is observed between the level of knowledge of designers and reported structural failures. Recommendations given in this paper are motivated by the fact that the proliferation of computers and the availability of powerful software have impacted structural analysis methodology. Author suggest and concludes that Much of this variability is reducible by more comprehensive codes and better training of professionals. Studies on human error in design indicate that such errors contribute to a substantial percentage of failures of structures. It must be stated that estimation of variability should not be the sole objective of the profession, but rather narrowing the variability down should be as well.

David V. Rosowsky et.al. [8] develops a probabilistic construction load process model for multistory reinforcedconcrete building construction. This model considers loads causing peak structural actions on floor slabs for two widely used shoring procedures and includes probability distributions and temporal characteristics of slab selfweight, sustained construction live loads, ‘‘material stacking’’ loads, and ‘‘move-in’’ loads. Construction load statistics derived from Monte Carlo simulation show that the mean of maximum construction loads exceeds nominal (design) service (occupancy) loads whenever the nominal live-to-dead load ratio is less than approximately 1.0. A Type I extreme value distribution provided the best fit to the inferred distributions of construction live loads. This paper describes a probabilistic construction load process model for multistory RC building construction. This model considers only loads causing peak structural actions and describes probabilistic models for slab self-weight, sustained construction live loads, material stacking loads, and move-in loads. Construction load statistics were derived from Monte Carlo simulation and compared with occupancy (in-service) loads for a range of shoring procedures, nominal load ratios, and construction periods. For instance, it was found that mean construction loads experienced by floor slabs exceed mean maximum service (occupancy) loads whenever the nominal live-to-dead load ratios are less than approximately 1.0.

Suleyman Adanur et.al [9] presents the construction stage analysis of suspension bridges using time dependent material properties. For this purpose, Humber Suspension Bridge built near Kingston upon Hull, England is chosen as an example. Finite element model of the bridge is constituted using SAP2000 program considering project drawings. Geometric nonlinearities are taken into consideration in the analysis using P-Delta large displacement criterion. The time dependent material strength of steel and concrete and geometric variations are included in the analysis. Time dependent material properties are considered as compressive strength, aging, shrinkage and creep for concrete, and relaxation for steel. The structural response of the bridge at different construction stages has been examined. Two different finite element analyses with and without construction stages are carried out and results are compared with each other. As analyses result, variation of the displacement and internal forces such as bending moment, axial forces and shear forces for bridge deck and towers are given with detail. It can be seen from the study that there are some differences between both analyses (with and without construction stages) and the results obtained from the construction stages are bigger. So, it is thought that construction stage analysis using time dependent material properties and geometric nonlinearity should be considered in order to obtain more realistic structural response of suspension bridges.

There are some differences between the results with and without the construction stages. It can be stated that the analysis without construction stages cannot give the reliable solutions. In this paper, both of the construction stages and time dependent material properties are considered in the finite element analysis of Humber Suspension Bridge. The analyses can be divided into three groups as construction stages analyses, time dependent material properties and, construction stages analyses with time dependent material properties. At the end of the analyses, the differences can be obtained and which analysis has an important effect on the structural elements of suspension bridges (concrete girder, hanger, cable and tower) can be investigated. To obtain real behaviour of engineering structures, construction stage analysis using time dependent material strength variations and geometric variations should be done. Especially it is very important for suspension bridges, because construction period continue along time and loads may be change during this period.

Taehun Ha et.al. [10] developed the construction sequence analysis programmer to predict and to solve the problems during the construction of the IB Tower, a 58-story reinforced concrete building. The building is simulated for its movement and forces for all stages of construction best possible. In addition, the developed program was used to set the preset amount at each level for axial shortening, and to predict the building verticality at the time of structural construction at each level and the remaining lateral movement until target time. Three types of field monitoring for actual movement of the building was also performed: strain measurement of column deformation using vibrating wire gauge, optical survey for lateral movement, and 3-dimensional laser scanning of as-built shape of the building for axial and lateral movement. The results of field monitoring confirmed the predicted value of the building movement. Author compared both methods

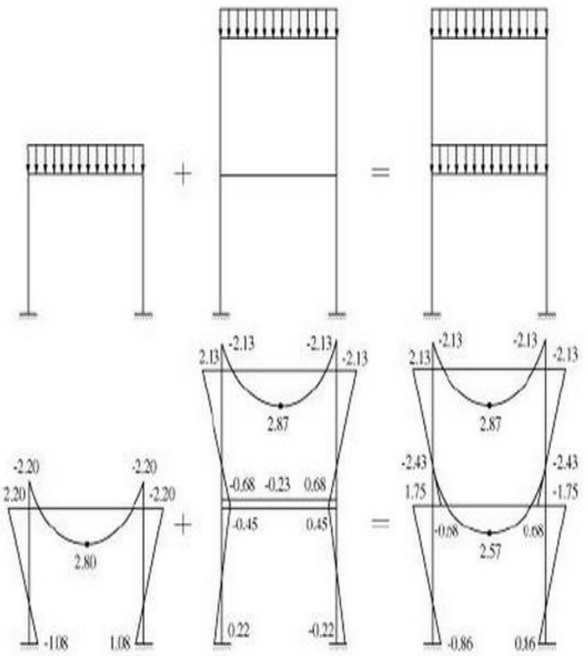

Fig.No.3. Construction sequence analysis

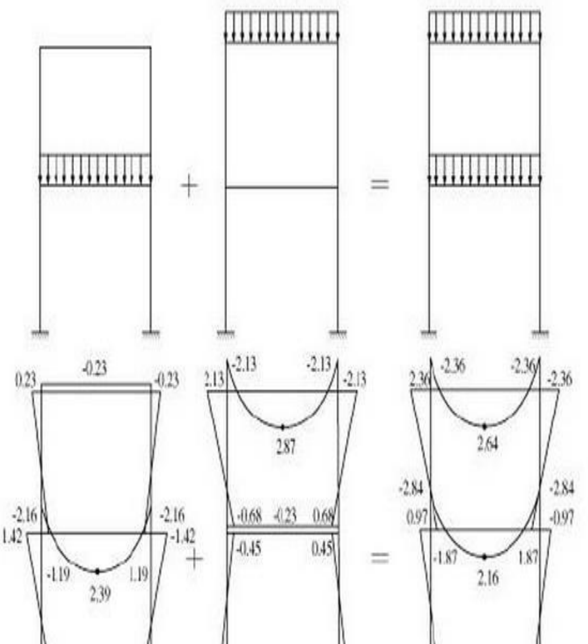

Fig.No.4. Conventional structural analysis

Mohammad yousuf et.al [11] brought up the concept of dynamic analysis of reinforced concrete building with plan irregularities. Author also determines the effect of irregular plan on structural response under seismic loading. He has done Dynamic analysis of framed structures using Response Spectrum Method by CQC method for 5%, 10%, 15%, and 20% damping.

In this study one can conclude that For higher and unsymmetrical buildings Response Spectrum Method should be used for symmetric building we can use lateral load equivalent method to the best way. But for unsymmetrical building requires more accurate analysis therefore Response Spectrum Method should be used. Irregularity in plan can result in complex dynamics and irregular response as the above discussion in performance analysis the irregular responses we are getting for models. Where Plan irregularities exist, check the lateral-force resisting elements using a dynamic analysis so that more realistic lateral load distribution can be achieved because irregularity in plan can result in irregular response so to resist the lateral loads it is necessary to check lateral- force resisting elements.

Pranay et al [12] studied two cases, in case 1 the multistoreyed building (22 storied) with floating columns and transfer girder were analysed as a whole for the subjected loading and in case 2 the multistoreyed building (22 storied) with floating columns and transfer girder were analysed with reference to the construction sequence or staged construction. A detailed study and comparison of the variation in deformations and forces was presented for the transfer girders, for the floating column on girders and for the frames which is above transfer girders. The building is analysed and designed using ETABS software.

Yousuf Dinar. [13] draws attention towards the fact that 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. 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.

The study reveals the necessity of 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. In the case of displacement sequence considered structure have much worst side condition than the linear static considered structures and it pushes toward the sequence considered. Analysis outcomes significantly changes to worst side under construction sequential analysis from the linear static analysis so to build a high-rise which involves construction of many floor and with longer time of construction sequential effects is obligatory to be considered. Construction sequential analysis also draws a preference of steel structures over the RCC structures for long term loading effects.

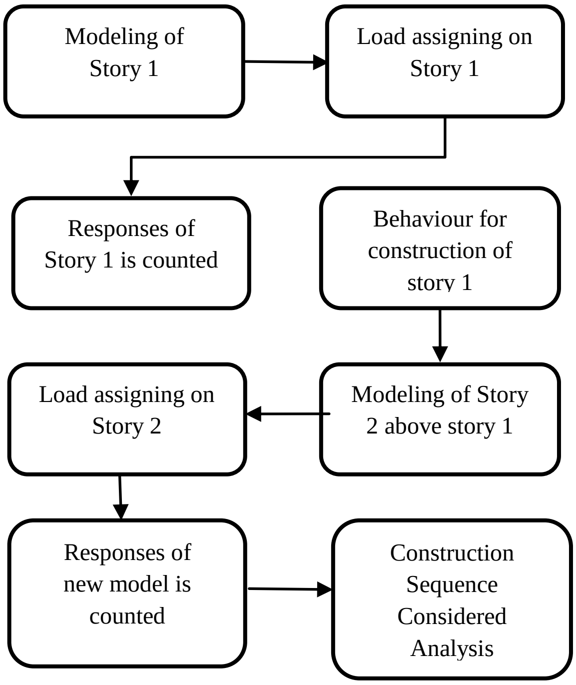

Fig.No.3. Stages of Construction sequence analysis

K.M. Pathan et.al. [14] analyzes several numbers of multistorey reinforced concrete building frames of different bay width and length, storey height and number of stories using STAADpro, followed by the construction stage analysis of each model. Also all full frame models are analyzed for earthquake forces in Zone - II (IS 1893 : 2002). Finally, a comparative study of Axial forces, Bending moments, Shear forces and Twisting moments was done at every storey for full frame model (without earthquake forces) and construction stage model (without earthquake forces). After analysis they conclude that No significant advantage in case of column design is considered but there is a scope to check the columns considering the primary rotations at every stage. Interior beams are always critical in construction stage as far as design moments are considered. Construction stage analysis is proved critical even if earthquake forces during the construction are not considered. This paper also mentioned that Construction stage analysis considering earthquake forces will provide more reliable results and recommended in usual practice

Chang-koon choi et al. [15] dealt with the bending moments and shear forces that induces in the members of the frame by the differential column shortening, taking into account the construction sequence and the sequential application of dead weight in the analysis. 57-story building (Republic Bank Center, Korea) is used for analysis purpose. The entire frame is analyzed by "one substructure at a time" approach in the reverse order of construction. Numerical examples of two high-rise buildings clearly show the significance of the differential column shortening effects. The results obtained in this study have shown that the differential column shortening and the bending moments induced by it in the gravity analysis of entire frame are very significant and should not be neglected in the analysis of the high-rise buildings.

3. CONCLUSION

From the above discussion, it can be concluded that a large number of research studies have addressed sequential analysis as an important factor to be considered while designing the structure. Majority study have found the results related to displacements, base shear, moments of the structure while load is applied. Some researchers have considered the vertical irregularity of structure by designing a floating column and creating a transfer girder. From the comparison results it is found that for conventional analysis results are underestimated for the bottom floors and the same are over estimated in the upper floors when compared with construction stage analysis. From the results of column shortening it is found that the value of it is over estimated for upper floors and under estimated for lower floors in case of conventional analysis. Some researchers have analyzed both RCC and Steel structures while some have analyzed only RCC buildings and from their study it was found that RCC structure in case of sequential analysis follow an identical order i.e. with the increasing story the variation decreases but steel structure does not follow any identical order. Thus, from all studies it is concluded that construction sequential analysis gives better results as compared to conventional analysis and therefore it should not be neglected while designing any structure. It is needed to do some comparative research of both i.e. construction sequence analysis and conventional analysis by considering Earthquake forces for different sizes of bay and for different height.

REFERENCES

[1] Kenneth L. Carper., "Structural failures during construction" Journal of performance of constructed facilities, ASCE, Vol. 1, No. 3 ppr no.21719, 1987.

[2] Xila Liu, Wai-Fah Chen. and Mark D. Bowman. , "construction load analysis for concrete structures" Journal of Structural Engineering, ASCE, Vol. 111, No. 5,ppr no.19719, 1985.

[3] Hassan Saffarini. , "Multistory frames under sequential Gravity loads " Journal of Civil Engineering, ASCE, Vol. 12,No. 3, pp. 645-652, 1985.

[4] Chang-Koon Choi, E-Doo Kim, "Multistory Frames Under Uequential Gravity Loads", Journal of Structural Engineering, ASCE, Vol. 118, No. 4 ,pp.2373-2384, 1985

[5] H.M. Lee.X.L.Liu and W.F. Chen., "Creep Analysis of concrete building during construction" Journal of Structural Engineering, ASCE, Vol. 117, No. 10,ppr no.26293, 1991.

[6] Chang-Koon Choi, Hye-Kyo Chung, Dong-Guen Lee, and E.L.Wilson."Simplified Building analysis with sequential dead load -CFM" Journal of Structural Engineering, ASCE, Vol. 118, No. 4 ,ppr no.303, 1992.

[7] Basher Alamin.,"Analysis of Construction load on Concrete formwork", A thesis in the department of

ISSN: 2456-9976

Building, Civil and Environmental Engineering, Concordia University, Canada,1999

[8] Hassan Saffarini, "Overview of Uncertainty in Structural Analysis Assumptions for RC Buildings," Journal of Structural Engineering ASCE, v.126, pp. 1078-1085. 2000

[9] David V. Rosowsky1 and Mark G. Stewart, "Probabilistic Construction Load Model for Multistorey Reinforced-Concrete Buildings," Journal of Performance of Constructed Facilities ASCE, v.15, pp. 144-152,2001.

[10] Süleyman Adanur a, Murat Günaydin b , Ahmet Can Altunis, Barıs Sevim, " Construction stage analysis of Humber Suspension Bridge", Journal of Mathematical modelling, Elsevier Science Direct, Vol. 36, pp.5492 - 5505, 2012.

[11] Taehun Ha and Sungho Lee, "Advanced Construction Stage Analysis of High-rise Building Considering Creep and Shrinkage of Concrete", The 2013 world congress on Advances in structural Engineering and Mechanics,Jeju, korea, 2013

[12] Mohammed yousuf, P.M. shimpale. , " Dynamic Analysis of Reinforced Concrete Building with Plan irregularities", International Journal of Emerging Technology and Advanced Engineering,Vol.3,Issue.9,pp.110-116, 2013.

[13] K M Pathan, Sayyad Wajed Ali, Hanzala T Khan, M S Mirza, Mohd Waseem, Shaikh Zubair, "Construction Stage Analysis of RCC Frames", International Journal of Engineering & Technology Research Volume-2, Issue-3, pp. 54-58,2014.

[14] R. Pranay, I. Yamini Sreevalli, Er. Thota. Suneel Kumar, "Study and Comparison of Construction Sequence Analysis with Conventional Lumped Analysis Using Etabs"

[15] Yousuf Dinar, Munshi Md. Rasel, Muhammad Junaid Absar Chowdhury and Md. Abu Ashraf, "Chronological Construction Sequence Effects on Reinforced Concrete and Steel Buildings," The International Journal Of Engineering And Science, v.3, pp. 52–63,2014.

About Authors

Mr. Mohammad Afifuddin N., PG Student, Shreeyash College of Engineering and Technology, Aurangabad, India.

Prof. Arvind B Vawhale,he received his Degree and Master Degree in Structural Engineering from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, and Maharashtra, India. He is currently working in Shreeyash College of Engineering and Technology, Aurangabad as Assistant Professor

Prof. N. S. Vaidkar,he received his Degree and Master Degree in Structural Engineering from Dr. Babasaheb Ambedkar Marathwada University, Aurangabad, and Maharashtra, India. He is currently working in Shreeyash College of Engineering and Technology, Aurangabad as Assistant Professor.