INTERNATIONAL JOURNAL OF
ENGINEERING MANAGEMENT SCIENCE
journal homepage: www.ijems.online/index.php/ijems/index

REVIEW PAPER ON ANALYTICAL STUDY ON THE STRUCTURE BEHAVIOUR OF REGULARAND IRREGULAR SPACE FRAME BYSTAAD.PROV8i

[1]D.R. Mohapatra,[2]Sundeep Behera,[3]Aditi Pattanaik,
[1,2,3] Senior Lecturer
[1,2,3]DepartmentofCivilEngineering
Ganesh Institute of Engineering & Technology, Bhubaneswar

Keywords
Symmetric and asymmetric Structure, Building Analysis, Storey Displacement, Base Shear, Storey Drift, STAAD-Pro v8i

Abstract
A procedure of optimizing aspacetruss only by varying the geometric shape of the truss and keeping the cross section of the element kept constant. The shape variations will be done on the basis of raising the height. The maximum deflection produced in the structure, weight of steel required by the structure and percentage of failed member has been considered as measured. Optimization is a process of subjecting all members present in the structure to minimum usage thereby ensuring the utilization ratio of each and every element more than 80%. It is to be noted that the structural properties not be compromised. The structure has to be made of limit state design and should be simply supported roof. Space truss design in the technique for assigning a structure using skeleton- type approach, as opposed to traditional piece -by - piece or ground- up construction. Irrespective of advantage of the structure economical efficiently of structure3 decides success of it. Hence the space truss will be designed and optimized during our project. The shape will be varied for the best result and optimized shape is to be determined.

I. INTRODUCTION

The growing interest in space frame structure has a witnessed worldwide over a last half century. It forms to accommodate large unobstructed area and satisfy the requirement for lightness economy and speedy construction. New and imaginative application of space frame are being demonstrated in the total range of building types such as sport arenas, exhibition pavilions assembly hall transportation terminals, airplane hangars, workshops warehouse. They have been used not only on long span roofs but also on mid and short span enclosure as roofs, floors exterior wall and canopies. But the space frame highly statically in determined and their analysis lead to extremely tedious computation if done by hand. The difficulty of complicated analysis as such system has contributed his limited use. But by using computer program it possible to analysis very complex space structure with greater accuracy and less time involved. A space frame or space structure is a truss like, lightweight rigid structure constructed from interlocking struts in a geometric pattern. Space frame can be used to span large areas with few interior supports. In practice the rigid jointed frames such as building frames are usually three-dimensional space structure. However, for simplicity in design, the space structure is considered as a number of independent plane frames interact with one another leading to a redistribution of internal forces and the development of torsional moments in the members of the space frame. Although the neglect of the torsional moments results in considerable simplification, it is neither economical not safe in all cases. A grid structure is another example in which the neglect of twisting moment is neither safe nor economical. In dealing with rigid jointed space frames, the rotational coordinates corresponding to rotations about three Cartesian axes and couples about them will be represented by double headed arrows in accordance with the vector notation and the right-handed screw system. Although the members of a grid structure generally lie in one plane, the twisting moments are present because the external loads are normal to the plane of the grid. In a very broad sense, the definition of the spaceframe is literally a three-dimensional structure. However, in a more restricted sense, space frame means some type of special structure action in three dimensions. Sometimes structural engineers and architects seem to fail to convey with it what they really want to communicate.

II. LITERATURE REVIEW

Manmohan Singh Thakur1, Dr. Suman Sharma (2017) Objective of this research to study vibration of two different types of frame one is square and other is tubular frame. In this work we will go to compared natural frequency of vibration between a tubular and square frame and trying to take some conclusion. In this analysis we will obtain vibration behavior of motorcycle frame with different cross-section. In this research we took two materials one is aluminium and other is steel.

Disha Sahadevan1, Megha Vijayan (2017) describes the maximum displacement, storey drift and stiffness are analysed inregular and irregular building with square columns, circular column and with specially shaped columns. The maximum displacement is decreased for G+9 stories ranges is from 20% to 30%. The storey drift is decreased by 20% - 40% in Z shaped column while comparing with the equivalent square, circle column in G+9 stories. The stiffness is increased by 60% in Z shaped column while comparing with the equivalent square,circle column inG+9stories.The specially shaped Z column achieves these categories.

Anuja Dhatrak1, Dr. R. S. Talikoti (2016) ,In this project a steel building model is taken, this model is compared in different aspects such as Natural frequencies, fundamental time period, inter story drift and base shear etc. using different bracing configuration in different locations. After the numbers of trial, the results of seismic analysis of high rise steel building with different pattern of bracing system which type of bracing at which location is more suitable would be selected for the structure.

K. Selvam,R.Divyameena (2016),This project deals with the optimization of steel space truss. Optimization is a process of subject in gall members present in the structure to minimum usage there by ensuring the utilization ratio of each and every element more than 80%. It is to be noted that the structural properties not be compromised. The structure has to be made of l imit state design and should be simply supported roof. Space truss design is the technique for assigning a structure using skeleton -type approach,as opposed to traditional piece-by-piece or ground-up construction.Irrespective of advantage of the structure,economical efficiently of structure decides success of it. Hence the space truss was designed and optimized during our project. The shapes were varied for the best result and optimized shape was achieved. From this optimized shape trials were carried out with different depths and finally concluded the best.

Aniket NTolani, AniketS.Patil, GaneshN.Patil, VedangH.Vadalkar (2016),These structures exhibitnon-linear behaviour, as opposed to linear relationships observed in conventional structures,which use steel as primary material resource.The non-linear relationship can be observed in geometry as well as in material aspects. These have been presented in the first part of this paper. The second part focuses on comparison of tensile structures over space frames structures which are generally used .The area selected forth stated purpose is an entrance can opt Computer aids like Staad.Pro .The end conclusion, which the study aims to show,is that the tensile membrane structure could outmatch the conventional systems in terms of construction difficulties, economic liabilities and resource/material requirement.

SARIKAB.SHINDE, M.SHIMPALE (2015) aim of this paper is to the study double layer barrel vault (DLBV) of 3D trusstype. Barrel vault are popular way of spanning large areas with few intermediate supports Truss type double layer barrel vault issimple structural formation made up of network of longitudinal, transverse and braced member with curvature in one direction only.Truss type barrel vault are analysed and designed for different load such as live load, wind load and the combination of loads. Thetruss type barrel vault is designed as per IS: 800-2007and analysis performed by using STAAD. Pro 2007. This work leads to the comparison on span, maximum deflection, self-weight and cost criterions

Prakarsh A. Sangave, Shubhangi M. Nikate (2015), In this project optimization was carried out on whole building frame noton an individual element. The fundamental optimization criterion chosen is the area of reinforcement per square feet. Analysis and design results are presented in the form of required area of reinforcement per square feet in (mm2) in optimization techniques for overall structure. The result shows that, after application of different optimization methodologies, a significant saving in cost of material and there by the cost of construction can be done.

M. Overend , and G.A.R. Parke (2015) ,However, to date there is still no agreement on a definite mathematical model that accurately predicts the failure of glass, hence resulting in disjointed and sometimes conflicting design data for this brittle unforgiving material.This induces engineers to adopt large factors of safety and devise in efficient glass structures. A design methodology is therefore advanced to determine the strength of annealed and tempered glass panels. This paper provides an overview of this method and gives examples of its application.

Dhananjay.S.Pawar, S.Abdulla, U. Phadnis, Ravi.G.maske, Raju .S.Shinde4 (2015) The horizontal movement is the most specific feature of earthquake action because of its strength and because structures are generally better designed to resist gravity than horizontal forces. These forces produce large stresses, strains, deformation and displacement particularly in tall structures. To keep displacement within limit generally bracing is provided in steel structure. Bracings are generally used to increase lateral-stiffness,lateral- strength as well as lateral stability of the frame. Variations in the column stiffness can influence the mode of failure and lateral stiffness of the bracing. In this study steel frame is modelled and analysed three Parts viz., (i) Model without Steel bracing (bare frame), (ii) Model completely with fully braced steel frame („Cross" bracing), (iii) Model completely with fully braced steel frame(„Single diagonal" bracing).

Amit Kumar, Anant Kumar, Shyam Kishor Kumar, Krishna Murari (2014) , The seismic inertia forces generated at its floorlevels are transferred through the various beams and columns to the ground. The failure of a column can affect the stability of the whole building, but the failure of a beam causes localized effect. Therefore, it is better to make beams to be the ductile weak links than columns. This method of designing RC buildings is called the strong-column weak-beam design method. If the frame is designed on the basis of strong column-weak beam concept the possibilities of collapse due to sway mechanisms can be completely eliminated.In multi storey frame this can be achieved by allowing the plastic hinges to form, in a predetermined sequence only at the ends of all the beams while the columns remain essentially in elastic stage and by avoiding shear mode of failures in columns and beams. This procedure for design is known as Capacity based design which would be the future design philosophy for earthquake resistant design of multistoreyed reinforced concrete frames.

Pei-Shan Chen (2014) describes the Space Frame, which is invented by the author, is a bar-linked structure configured withone-layer of chords and diagonal members [1,2]. Unlike a conventional double layer space frame, the 1.5-Layer Space Frame has nolower chords, or when it is oriented upside down, no upper chords. And unlike a single layer space frame, diagonal members are mounted onto the latticed surface and efficiently strengthen that the entire structure can be constructed in subtle curvatures or asa plane. The present paper introduces the geometrical features of the 1.5-Layer Space Frame and presents more configuration patterns to construct variations of the 1.5-Layer Space Frames in planar and curved forms.

AnshulSud, Raghav Singh Shekhawat, Poonam Dhima (2014) describes the most basic lateral load resisting elements in an earth quake resistant building. To avoid torsion in buildings, shear walls must be placed symmetrically in plan. In this paper, a five-storey RC building located in seismic zone-Vis considered with four shear walls. Five different configurations of shear walls viz.bare frame, shear wall symmetrically placed at exterior bays (centrally), at core and adjacently placed in exterior of the building, are considered. These frames are analysed for seismic forces to assess performance in terms of base shear, storey drift, member forces and joint displacements. The frame with shear walls at core and centrally placed at exterior bays showed significant reduction of order29% to 83% in lateral displacement.The reduction in bending moments is approximately 70% to 85% for interior and perimeter columns respectively. Shear and axial forces in columns have reduced by 86% and 45% respectively.Based on such results, the bestplacementofshearwallsinbuildingplanissuggested.

D. Jain and M. S. Hora (2014),. The interaction analysis is carried out with and without shear wall to investigate the effect of inclusion of shear wall on the forces in the footings due to differential settlement of soil mass. The frame and soil mass both are considered to behave in linear elastic manner. It is observed that the soil-structure interaction effect significantly alters the axial forces and moments in the footings due to the differential settlement. The non-interaction analysis of space-frame-shear wall suggests that the presence of shear wall significantly reduces bending moments in most of the column footings but the interaction effect causes restoration of the bending moments to a great extent.

Ms. S. D. Ambadkar& Prof. Dr. P. S. Pajgade, (2012) This paper discusses LCC of RCC Industrial Building (G+2) compared with LCC OF Steel Industrial Building (G+2) with Hollow Columns & steel Deck & LCC of Steel Industrial Building with I-section columns &steel deck.

ShilinDONGa(2012)Theapplicationofprestressingtechnologyandtheinnovationofstructuralconceptsandconfigurationsarealsoassociatedwithmodernspacestructures,including composite space trusses,open-web grid structures,polyhedron space frame structures, partial double-layer lattice shells, cable-stayed grid structures, tree-type structures, prestressed segmental steel structures and so forth..This paper provides a review of the structural characteristics and practical applications in China of modern rigid space structures,modern flexible space structures and modern rigid-flexible combined space structures.

L. K.Sangle,K.M.Bajoria, V.Mhalungkar (2009) ,In this paper the linear time history analysis is carried out on high rise steel building with different pattern of bracing system for Northridge earthquake.Natural frequencies, fundamental time period, mode shapes, inter story drift and base shear are calculated with different pattern of bracing system. Further optimization study was carried out to decide the suitable type of the bracing pattern by keeping the inter-story drift, total lateral displacement and stress level within permissible limit. Aim of study was to compare the results of seismic analysis of high rise steel building with different pattern of bracing system and without bracing system.

M. HouGuangyu , Chen Binlei , Miao Qisong, Liu Xiangyang , Huang Jia(2008)This paper presents the design, research and relatedjoints' details of a 31-story composite frame-core wall structure, which is located in Beijing City, a region of seismic fortification of 8degree. In order to improve the ductility, bearing capacity of the core walls and to ensure inelastic deformation capacity of the longitudinal coupling beams carried steel trusses, propersteelframeswereembeddedwithinthelongitudinalcorewalls.The results of elasto-plastic time-history analysis under the action of rarely occurring earthquake are very close to the data of shaking table test.Experimental results show that there are no obvious cracks in the core walls, spalling of concrete and local buckling of reinforcement at the bottom of the core wall's boundary elements and the composite columns at the perimeter have not been observed, even the elasto-plastic story drift angle has reached1/101, the whole structure has better seismic performance. However,higher strain measurement of the floor beam end during the rarely occurring earthquake shows partial restraining moment should be considered at the connection.

N. Kim, Jin-Woo1, Kim, Taek-Soo, and Lee, Yong-Hee (2006)In this paper, test model consists of uniform pyramids with ball type joint, the structure is shaped and erected into its final curved space structures. The feasibility of the proposed post-tensioning technique and the reliability of the established geometric model were confirmed with finite element analysis and experiment for a small-scale test model. As a result, proposed post-tensioning technique could be applied the shaping formation of space structure with ball type joint, so we can know the characteristic of the behaviour in shaping test for practical design purposes, it should be an economic and reasonable method compare to conventional construction method including the heavy crane and scaffold.

O. NaokiNIWA, Seiji AKIYAMA, Kazunari MAKIBE4 and AkioTOMITA(2004) These characteristics give flexibility to building planning and future possible renovations.The seismic response analysis results illustrated that the earth quake-resistance standards of Japan, a sa severely seismic country, could be satisfied, and the boundary beams reduced the seismic response.The loading tests confirmed that the shear strength and bending characteristics of the earthquake-resisting walls with built-in steel could be evaluated by conventional design equations for reinforced concrete earth quake-resisting walls. It was also verified that the boundary beams proposed had a large equivalent damping factor and could decrease damage compared with boundary beams of normal cross-sections.

R. Soegiarso(2003) The structure is subjected to wind loading according to the Uniform Building Code (UBC) in addition to the vertical loads due to dead and live loads. A scaling procedure is developed that results in fast convergence. The algorithm is applied to minimum weight design of four large high-rise steel building structures ranging in height from 20 to 81 stories and in size from 1,920 to 9,245 members. A comparison of designs of space moment-resisting frames based on the AISC LRFD code with those based on the AISC Allowable Stress Design (ASD) code shows the former results in a lighter structure for the examples presented.Nowadays architecture is designed in simple shapes, cube form and geometrical volume. This is caused by structure system in a building; we must follow structure to achieve design forms. This is a time for the rejuvenation of architectural forms, shapes and space. In some countries there is earthquake problem, which need a structural system that can give better resistance against earthquake and ensure a stable building.

Dr Kumar (2001) The structure is subjected to wind loading according to the Uniform Building Code (UBC) in addition to the vertical loads due to dead and live loads.Ascalingprocedureisdevelopedthatresultsinfastconvergence.The algorithm is applied to minimum weight design of four large high-rise steel building structures ranging in height from 20 to 81 stories and in sizefrom 1,920 to 9,245 members. A comparison of designs of space moment-resisting frames based on the AISC LRFD code with Those based on the AISC Allowable Stress Design(ASD)code shows the former results in a lighter structure for the examples presented.

Fattah K. Abbas Adel abdul Jabbar AL-Waily (2000) It is concluded that in spite of the fact that the amount of different rotation between beam and column is relatively small in the loaded frame structures, this differential rotation has a significant effect on the geometrical behaviour of frame structures and consequently on the design of their elements. It has been shown that the consideration of semi-rigid connections in the analysis of frame structures is of great importance.

Ioannis Mitsos, Simon D. Guest, Pete Winslow (2007) This paper describes an experimental investigation into a half-scale structural model of a solar collector double layer tensegrity space grid that was originally proposed to cover the new National OperaHouse in Athens, Greece. The structural scale model has a 5m span with cubic modules of 1.25m edge length. The key purpose of the experiment is to investigate the construction sequence, and, in particular, the pre-stressing of the structure.A novel pre-stressing scheme is used, where the top and bottom horizontal members are jacked apart, and a vertical compression member is lengthened. In practice, verification of pre-stressing is important, and a practical technique for measuring prestress in the diagonal members in the field through vibration measurements is described.

III. CONCLUSIONS

This review paper provides information on various factors the help in understanding of factors effecting design and analysis of space frame structure. The lateral load resisting capacity of frame increases significantly in case of steel frame introduction as is clear from the storey developed maximum displacements. As compared to bare frames, braced frame has drastically less value of maximum lateral displacements also the values are within the permissible limits. Fully braced frame as well as optimally braced frames with soft storey is found to be more flexible at intermediate level than that at ground level. When provision of soft storey is a must at that time optimally braced frames are found to be best suited compared with the fully braced structure with soft storey, partially braced frames satisfying the adopted acceptance criteria revealed that as single bay braced and two bay braced yield optimum positions from viewpoint of minimising the cost. It also increases flexibility of the structure so as to have displacements with in permissible limits. For cross and single diagonal type frame axial force in penultimate Colum is reduces as compare to end column. The same result is observed for different height of the space frame structure.

IV. ACKNOWLEDGEMENT

The satisfaction and euphoria on the successful completion of any task would be incomplete without the mention of the people whose constant guidance and encouragement crowned my effort with success.I would also like to take this opportunity to express heard felt gratitude for my dissertation guide Mr. Sabih Ahmad Associate Professor & co-guide Mr. Anwar Ahmad Associate Professor Department of Civil Engineering, Integral University, Lucknow for his guidance, who provided me with valuable inputs at each and every moment and also at critical stages of this dissertation.I would like to thanks Dr. Syed Aqeel Ahmad, Prof. & Head of Department of Civil Engineering, Integral University, Lucknow for his support, valuable suggestions and providing the lab facilities required for the project work.I would also like to thank the whole Civil Engineering Department, Integral University, Lucknow, for providing proper environment and encouragement for carrying out the project.

REFRENCES

[1] Calladine,C.R.(1978).“Buckminster Fuller’s Tensegrity Structures and Clerk Maxwell’s Rule for the Construction of Stiff Frames.”

[2] Clarke,M.J. and Hancock,G.J.(1995).”Test and Nonlinear Analysis of Small-scale Stressed-arch Frames.”

[3] June14-16,2006-Montréal, Canada Joint International Conference on Computing and Decision Makingin Civil and Building Engineering.

[4] Dehdashti, G. ,and Schmidt,L.C. (1996).“Dome-shaped Space Trusses Formed by means of Post-tensioning. ”Journal of Structural Engineering,

[5] KimJ.W.(2000).“Analysis and Test of Dome-shaped Space Truss.”Journal of the Korea Society of Civil Engineers.

[6] Kim,J.W.,andHao,J.(2002).“Behaviour Characteristic of a Full-size Scale Pyramidal Space Truss Unit.” KSCE Journal of Civil Engineering.

[7] KimJ.W., HaoandLee (2001).“New Attachment Device for Post-tensioning of Full Size Scale SpaceTruss.

[8] Kim,J.W.andSchmidt,L.C.(2000).”Test of Deployable Dome-Shaped Space Truss.” International Conference on Computingin Civil and Building Engineering.

[9] Kim,J.W., Kim,J.J., and Lee, J.W.(2002).“Form Finding and Experiments for Three Types of Space Trusses.” Space Structures.

[10] Kim,J.W.,Kim,J.J.,andRhew,H.J.(2004).“Analysis and Experiment for Self-erected Hypar Space Truss.” Proceedings of the Second International Conference on Structural Engineering, Mechanicsand Computation.

[11] Kim, J.W.,Kim,J.J.,and Rhew,H.J.(2006).“Analysis and Experiment for the Formation and Ultimate Load Testing of a Hypar Space Truss.

[12] KimJ.W.,KwonM.H.,andRhew,H.J.(2005).“Shaping Formation and Nonlinear Analysis of Mero Jointed Space Structure with Multi-directional Joint.”

[13] Schmidt,L.C.&Selby,S.(1999).“Domical Space Trusses and Braced Domes: Shaping, Ultimate Strength and Stiffness.”

[14] Schmidt,L. C. and Steven Selby(2001).”Shape Formation of some Dome-like SpaceTrusses.”

[15] Alvarez, F.Guichard, P.-L. Lions,and J.-M.Morel,\Axioms and fundamental equations of image processing.

[16] J.Babaud,A.P.Witkin,M. Baudin,and R.O.Duda,\Uniqueness of the Gaussian kernel for scale-space ltering",

[17] J.BurtandE.H.Adelson,\The Laplacian pyramid as a compact image code",

[18]J.Canny,\A computational approach to edge detection",

[19]Chehikian and J. L. Crowley, \Fast computation of optimal semi-octavepyramids", in Proc. 7th Scandinavian Conf. on Image