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Literature Review on Analysis of Modular Building Using E-Tabs Software

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***Abstract*- Modular building with advantages of quick installation, good comfort,beautiful appearance and convenient turnover, is widely used in construction of temporaryconstruction, business services, holiday villas and other projects.The paper aims an analysis of modular buildings by using E-tabs software. It focusesupon basic design assumptions that are accepted for modular buildings.There are so many software. using now a days to analyse a s structural buildings but in the case of modular buildings the analysis by using E-TABS is an innovative solution.And also to steel is better than an ordinary construction based on their strength and also regarding with other factors. The software is using here to analyse the modular construction. Different models were developed in the E-TABSSoftware to research the analyticalperformance of ordinary structures.Current project E-TABS is used to calculate the overall structural strengthand stiffness, and the stress and displacement calculation results under the control of verticalload and horizontal wind load.**

***Keywords*- E-TABS Software, Modular building, Seismic analysis, Lateral analysis.**

I. INTRODUCTION

Building construction by using a modular technology is presently considered as one of the most progressive directions in civil engineering . Such buildings have a number of advantages compared to the classical technology of construction: low labour intensity of construction, high speed of installation, high quality of modules, etc. These advantages are especially important for the construction of buildings in inaccessible regions with extreme climatic conditions, e.g. areas of oil and gas fields development.

Despite the active implementation of modular buildings in Russia, there is no regulatory framework for this type of structures design. This is primarily due to the lack of analytical methods for calculating modular buildings. Currently, the finite element method (FEM) is used for the calculation of buildings and structures. This method makes it possible to calculate the forces in any building structures. However, FEM has a disadvantage associated with the need to know the exact geometry and cross-sections of structural elements, while there is no direct connection between them. When using FEM, the calculation of a private scheme is performed every time, so it is difficult to identify general patterns in the work of forces modular buildings.This paper presents an analytical method of modular buildings calculation that does not require major calculation schemes in software systems using FEM. This method makes it possible to quickly calculate the forces in the elements of modular units. Modular construction offers faster and safer manufacturing, better predictability to completion time, superior quality, less workers on site, less resource wastage, and a more environmentally friendly solution than the conventional construction process. Despite having several advantages of modular construction, the private sector still relies heavily on the traditional on-site construction method. To understand the scientific reason behind this situation.

II. LITERATURE REVIEW

Yi Yang,Wei Pan,Mi Pan: Manufacturing of modular buildings: a literature review(November 2017): This paper aims to provide a systematic review of existing academic perspectives and suggest future research directions to improve module manufacturing systems. The review explores critical research issues from five aspects: process and activities, organisation and people, factory configuration, technology, and information and control system. Outlined suggestions for research opportunities include (1) increased utilisation of digital manufacturing, (2) more exploration of strategies for the adoption of automated technologies, (3) development of holistic and practical approaches to supporting DfMA methodology, (4) well-defined information management systems through BIM. The findings should contribute to a more comprehensive understanding of the practices, challenges and the state-of-the-art research in the manufacturing of modular buildings.

Viacheslav Shirokov,T E Gordeeva,A Yu Bocharov:Analytic method of structural analysis of modular buildings(April 2020): The paper presents an

analytical method of modular buildings calculation. It focuses upon basic design assumptions that are accepted for modular buildings calculation. The authors introduce their classification of loads and impacts, which are basic for modular buildings. They also describe a method of determining inertial forces from seismic action designed on the basis of a cantilever analytical model. Analytical and numerical methods for determining the forces in the elements of modular units are further compared. It is revealed that the analytical method strongly agrees with FEM (that is the finite elements method) with the error being 2-6%. The analytical method is sufficiently accurate for engineering calculations.

Gauchel,Hovestadt, Van Wyk, S.and Bhat:Modular Building Models(January 1993) :Current research suggests that to model real-world complexity, one must trade centralized control for autonomy. In this paper we develop a modular approach to building modelling that is based on object-oriented autonomy and makes it possible to define these models in a distributed concurrent manner. Such a modular and autonomous implementation brings inherent uncertainty and conflict which cannot be determined a priori. Steel modular building structures are being increasingly adopted for a variety of building applications since their method of construction, despite being relatively new, offers many benefits over conventional constructional methods. Even though their behaviour under gravity (dead and live) loads is generally well understood, their response to lateral dynamic loads such as seismic and wind loads, is relatively less known. Due to their unique structural detailing, their structural response and failure patterns under lateral dynamic loading can vary considerably from that exhibited by conventional structures. Limited research has shown that under lateral loadings, modular structures tend to fail at the columns which are critical members whose failure can lead to partial or total collapse of the structure.

Mc Guire Modular building block(November 2020):This patent describes a modular building block comprising an enclosure defined by end walls, side walls, a top wall and a bottom wall in an assembled relationship. The top wall includes a pattern of fastener slots and the bottom wall includes fastener tabs selectively slidable into a cooperable locking relationship in both vertical and horizontal directions with fastener slots in the top wall of another enclosure therebelow. Certain of the fastener slots in the top wall are disposed parallel to the longitudinal axis and along opposite edges thereof adjacent each of the side walls of the enclosure and other of the fastener slots are normal to the longitudinal axis at the midregion of the enclosure and along an edge thereof adjacent each of the end walls of the enclosure. The fastener tabs each include a cut-out portion overlaid by the top wall of another enclosure at an assembled condition.

Shaham Asadi, Ataollah Beigzade. Cheap and High Quality Housing with Emphasis on Modular Building(September 2017): Housing as one of the most basic needs of human being has received much attention. As a physical shelter, it is a fundamental need in each family. The need to housing has been increased based on the population increase in cities and its high density and it is a big problem in cities. High price of housing and lack of quality including construction materials to form and cultural quality is one of the greatest concerns of most of families. The study to create methods or types of design is necessary to provide comfort and many suitable housing indices and quality indices. Quality issue in housing increases the price. To reduce construction time and improvement of construction operation, modular building is used in the world. This method is a good model in construction for housing mass production. It should be considered that housing as living place of human being should be mostly regarding cultural issues than a symbol for the life and survival of human being. The study design is descriptive-analytic. The data is collected via existing articles and resources to present a strategy to eliminate the problem of cheap housing. The problem of cheap housing gives some feedbacks regarding the materials or climatic and cultural patterns of society and also it creates problems in society and people as low-income class. The present study aimed to approach two paradoxes of cheap price and quality (including materials and culture).

J.Zhang,Y.Lu,GLi Structural Analysis on Mechanical Properties of 3D Steel Structure Modular Buildings (August 2015): Modular building is a highly pre-fabricated construction system, and most structural members are made in the factory. There are many successful modular system construction cases abroad. However, the research on modular structure starts relatively late in China, and the research outcome is still limited. The cold-forming thin-walled steel joist system is a widely used modular system. Based on the force transferring mechanism, this modular system has two types: column-bearing system and wall-bearing system. Considering the influence of the story, opening and depth, the mechanical characteristics of these two systems, structural performance, and steel consumption are evaluated using finite element method. Finally, reasonable application scope and designing methods are proposed based on the comparison of analysis results. This paper provides a good reference for modular system construction in China. © 2015, Progress in Steel Buiding Structures All right reserved.

Tharaka Gunawardena,Tuan Duc Ngo,Priyan MendisBehaviour of Multi-Storey Prefabricated Modular Buildings under seismic loads(December 2016): This paper will therefore present the nonlinear time history analysis of a multi-storey modular building against several ground motion records. The critical elements that need special attention in designing a

modular building in similar seismic conditions is discussed with a deeper explanation of the behaviour of the overall system. Prefabricated Modular Buildings are increasingly becoming popular in the construction industry as a method to achieve financially economical buildings in a very short construction time. This increasing demand for modular construction has expanded into multi-storey applications where the effect of lateral loads such as seismic loads becomes critical. However, there is a lack of detailed scientific research that has explored the behaviour of modular buildings and their connection systems against seismic loads.

Sukhi Sendanayake,David P. Thambiratnam,Nimal Jayantha Perera, Tommy Chan. Seismic mitigation of steel modular building structures through innovative inter-modular connections(November 2019): This paper aims to mitigate this by shifting the failure away from the columns to inter-modular connections which can be allowed to deform in a ductile manner. Towards this end, this paper proposes two innovative inter-modular connections and investigates their performance under monotonic and cyclic lateral loading using comprehensive validated numerical techniques. The proposed connections have an additional steel plate and resilient layers to provide increased ductility and dissipation of seismic energy with desired ductile failure mechanisms. Three-dimensional numerical models of the proposed connections are developed in ABAQUS software considering geometric and material nonlinearities, as well as contact formulations to accurately capture their response to the lateral loads and failure propagations. The numerical model is verified based on experimental results in the literature and used for extensive parametric studies.

Seismic reliance of the proposed connections in terms of ductility, failure patterns, and energy absorption are compared with those of a standard inter-modular connection currently used in modular buildings. The outcome of this study demonstrates that the proposed connections have superior dynamic performances compared to the standard inter-modular connections in use today. New information generated through this study will enable to improve life safety and dynamic performance of modular building structures under typical gravity loads as well as under seismic loading. : Civil engineering; Construction engineering; Structural analysis; Structural engineering; Structural mechanics; Failure mechanism; Innovative inter-modular connection; Lateral loading; Seismic mitigation; Steel modular structures Keywords: Civil engineering, Construction engineering, Structural analysis, Structural engineering, Structural mechanics, Failure mechanism, Innovative inter-modular connection, Lateral loading, Seismic mitigation, Steel modular structures.

Andrew Lacey,Wensu Chen,Hong Hao,Kaiming Bi. eview of Bolted Inter-Module Connections in Modular Steel Buildings(January 2019): In current practice, the force-displacement and moment-rotation behaviours of inter-module connections for modular steel buildings are established by a combination of theoretical, experimental, and numerical analyses. The simplified connection behaviour is then incorporated into a numerical model of the overall structure for analysis and design. For engineering design analysis, it is desirable to estimate the inter-module connection stiffness by means of simplified calculations. Methods for estimation of the stiffness of traditional steel connections are available in the literature, however, their application to inter-module connections (also known as inter-connections) remains to be investigated. This paper summarises existing inter-connection details, including their purpose and associated design methods and models. The inter-connections selected from the literature provide details of the typical force-displacement and moment-rotation behaviours. For the selected inter-connections, the numerical and experimental results are compared with the calculated theoretical results predicted by existing theoretical models. The existing theoretical models are compared, and their limitations are outlined.

Wahid Ferdous,Yu Bai,Tuan Duc Ngo New advancements, challenges and opportunities of multi-storey modular buildings-A state-of-the-art review(January 2019): This paper critically reviews the recent developments, performances, challenges and future opportunities of modular buildings. Modular constructions are extensively used for low-rise buildings and further attracts strong interest for multi-storey building structures. Prefabricated modules demonstrated satisfactory performance under static, dynamic impact, cyclic, seismic, blast, fire and long-term sustained loading, and offer environmental, economic and social benefits. The acceptance and application of modular construction will further spread with the development of design guidelines, more skilled workers, addressing handing and transportation difficulties, and the development of novel interlocking connections between modules. Recently, composite materials demonstrated high potential to manufacture prefabricated building modules. In Australia, it is expected that modular construction will increase from the current stage of 3% to 5-10% by year 2030.

Yisu Chen,Chao Hou,Jiahao Peng Stability study on tenon-connected SHS and CFST columns in modular construction(January 2019): This study aims to explore the theoretical and numerical stability analysis of a tenon-connected square hollow section (SHS) steel column to address the tying and stability issue in modular construction. Due to the excellent performance of composite structures in fire resistance and buckling prevention, concrete-filled steel tube (CFST) columns are also taken into account in the analysis to evaluate the feasibility of adopting composite sections in modular

buildings. Characteristic equations with three variables, i.e., the length ratio, the bending stiffness ratio and the rotational stiffness ratio, are generated from the fourth-order governing differential equations. The rotational stiffness ratio is recognized as the most significant factor, with interval analysis conducted for its mechanical significance and domain. Numerical analysis using ABAQUS is conducted for validation of characteristic equations. Recommendations and instructions in predicting the buckling performance of both SHS and CFST columns are then proposed.

Jianfei Zhang,Lin Peng,Yijian Shi,Baoguang Chen Finite element analysis of double-layer box type modular building (December 2019): Box - type modular building with advantages of quick installation, good comfort, beautiful appearance and convenient turnover, is widely used in construction of temporary construction, business services, holiday villas and other projects. In this paper, a single span double - layer box - type modular building in Shenzhen was taken as an example, using modular building system with a special-shaped corner column and cold-formed thin-walled beam. The finite element software ANSYS was used to calculate the overall structural strength and stiffness, and the stress and displacement calculation results under the control of vertical load and horizontal wind load were respectively given. The results show that under the snow load, the maximum stress of the whole structure is 163.14MPa, which appears in the middle of the second layer top frame purlin. Under the horizontal wind load, the maximum stress of the whole structure appears at the beam-to-column connection panel, and the stress of the first story is more unfavourable than that of the second one. The maximum displacement in the horizontal direction is 10.37mm. The maximum displacement angle between layers is 1/278. The above calculation results all meet the requirements of "Standard for design of steel structures" (GB50017-2017), which can ensure the safety and reliability during normal use. Furthermore, it can provide reference for the design and optimization of multi-storey box Building.

SukhiSendanayake,DavidP.Thambiratnam,Nimal Jayantha Perera,Tommy Chan:Seismic mitigation of steel modular building structures through innovative inter-modular connections(November 2019): This paper aims to mitigate this by shifting the failure away from the columns to inter-modular connections which can be allowed to deform in a ductile manner. Towards this end, this paper proposes two innovative inter-modular connections and investigates their performance under monotonic and cyclic lateral loading using comprehensive validated numerical techniques. The proposed connections have an additional steel plate and resilient layers to provide increased ductility and dissipation of seismic energy with desired ductile failure mechanisms. Three-dimensional numerical models of the proposed connections are developed in ABAQUS software considering geometric and material nonlinearities, as well as contact formulations to accurately capture their response to the lateral loads and failure propagations. The numerical model is verified based on experimental results in the literature and used for extensive parametric studies. Seismic reliance of the proposed connections in terms of ductility, failure patterns, and energy absorption are compared with those of a standard inter-modular connection currently used in modular buildings. The outcome of this study demonstrates that the proposed connections have superior dynamic performances compared to the standard inter-modular connections in use today. New information generated through this study will enable to improve life safety and dynamic performance of modular building structures under typical gravity loads as well as under seismic loading. : Civil engineering; Construction engineering; Structural analysis; Structural engineering; Structural mechanics; Failure mechanism; Innovative inter-modular connection; Lateral loading; Seismic mitigation; Steel modular structures Keywords: Civil engineering, Construction engineering, Structural analysis, Structural engineering, Structural mechanics, Failure mechanism, Innovative inter-modular connection, Lateral loading, Seismic mitigation, Steel modular structures.

Jaya Chandra,Static Analysis Structure using E-Tabs of Braced Tube(October 2020): In tall buildings, tubular structures have become a popular feature over the past few years. For all tall buildings, tubing in tube systems is especially tubes at the corners; the whole building behaves like a massive tube. Between the inner and outer tubes, lateral loads are exchanged. Different models were developed in the E-TABS V15 programme to research the seismic performance of tubes in tube structures by varying the position of the inner tubes. The structures are studied using a continuum method in which the horizontal slabs and beams connecting vertical components are considered to have equal distributed stiffness properties as a continuous connecting medium. To have a comparative analysis on the model, the equivalent static is evaluated Suitable. A tube contains a peripheral framed tube and a central tube interconnected by floor slabs in a tube framework. With smaller.

Elena M. Generalova,Viktor P. Generalov,Anna A. Kuznetsova,Modular Buildings in Modern Construction(December 2016): The article considers temporary methods of using modular units in construction. The advanced world experience in the construction of modular buildings is analyzed. It is emphasized that modular construction has the potential to shorten project design and engineering time, reduce costs and improve construction productivity. The installation of modular buildings is cost-efficient, safe and eco-friendly. Modern modular systems are based on using not only large elements such as «block rooms» but various small

3D building elements. The analysis result of Russian developments in the construction of modular buildings proves that Russia has great experience in the development of 3D reinforced concrete modules. As the research results the article shows promise for developing of modern modular construction systems in order to provide the population with affordable, comfortable and eco-friendly housing. The paper describes the prospects and relevance of introducing modular prefabricated units not only into low-rise but into multi-storey and high-rise construction as well.

Myung-Do Lee:Analysis of BIM Utilization for On-site Construction Planning in Modular Construction Project(January 2019) : This study aims to analyze the utilization of BIM for onsite construction planning in modular construction projects. First, a realistic BIM application was selected through literature review and expert interviews. Then, the construction plan of the modular projects was analyzed to classify the BIM application items into five different categories. The utilization of BIM in each category was then analyzed in terms of necessity and efficiency using a questionnaire. Finally, the BIM Utilization Index (BIM UI) was suggested based on the findings of the survey. As a results, the BIM UI for module point details, lifting plan, other installation details, site layout plan, and schedule plan was 0.811, 0.787, 0.770, 0.729, and 0.699, in the descending order of usability. In addition, through the findings of the study and interviews with experts, a case study for implementation of BIM in modular construction plan was conducted. The results of this study can be used as application guidelines for BIM in future modular construction projects.

Karthik Subramanya,Sharareh Kermanshachi,Behzad Rouhanizadeh :Modular Construction vs. Traditional Construction: Advantages and Limitations: A Comparative Study(June 2020): Aim of this study was to accomplish that by investigating its advantages and limitations and comparing them with traditional construction. The advantages were identified through a thorough literature review, and were classified into five categories: project schedule, project cost, labor safety, project quality and productivity, and environmental. The limitations were also investigated through the existing literature and classified into five categories: project planning, transportation, public and expert acceptance, establishment cost and cost due to complexity, and coordination. The results revealed that the advantages of modular construction outnumber its limitations; however, further technological development and research would lessen or mitigate the challenges. The results of this study highlight the main benefits and challenges associated with modular construction and will help project stakeholders choose between this method and conventional construction methods for their projects.

Martina Mlcochova,Pavel Rihak The Future of Architecture in Modular Construction(May 2016): Modular building is without question a world trend not unknown for the global building. Nowadays the future of architecture is discussed from the viewpoint of modular building. Modular building may have an exclusive role when dealing with current condition of architecture ant its future development. The article deals with the modular construction of the historical development and current trends. Construction speed, efficiency, quality materials. These are the common denominators of modular construction. However, it should be avoided technocratic construction without soul and try to instilling to modular construction aesthetic and quality parameters for building the modular architecture.

D. Farnsworth: Modular Construction in Tall Buildings(October 2015): Despite these challenges, modular construction and prefabrication are developing traction in the tall building industry today. A convergence of changes in technology, procurement strategies, and market conditions appears now to be underway, and will only increase the number of projects that adopt a modular approach.

Matthew Goh,Yang Miang Goh : Lean production theory-based simulation of modular construction processes(May 2019): This study aims to conduct a detailed simulation study of modular construction operations, otherwise known as Prefabricated Prefinished Volumetric Construction (PPVC) in Singapore. In contrast with existing research, which are frequently focused on the barriers and drivers to the adoption of prefabrication, this study will provide and evaluate recommendations to improve modular construction efficiency through application of Lean concepts.

A detailed baseline (As-Is) simulation model of an ongoing PPVC project case study was first developed. Lean Construction principles were then applied to the baseline simulation model. Key Lean Construction principles and concepts implemented includes Total Quality Management, E-Kanban based Just-In-Time deliveries, cross training and the use of construction robotics. Lean (To-Be) simulation models were developed based on the Lean Construction principles. The outputs from the baseline and Lean models were compared to assess the impact of the proposed improvements. The findings demonstrated that through the application of Lean concepts, reductions in cycle time and process time, and increases in process efficiency and labor productivity can be achieved. The case study also provides a detailed description of the simulation approach, which is a useful reference for future application of simulation in offsite construction research.

III. SUMMARY OF LITERATUTE REVIEW

Summing up it should be noted that modular construction technologies are becoming widely used all over the world finding more and more applications. Modular construction is beyond the limits of low-rise construction and is extensively introduced into multi-storey and high-rise construction. In this direction energy saving construction technology is used. Material resources, eco-friendly production and the latest engineering equipment and materials are developed. It allows modernizing modular systems and introducing them in construction on a larger scale. It is very important that the use of modular units makes the construction cheaper including the construction of high-rise buildings. A myth that high-rise residential houses are only for the rich is being destroyed. This is one of the promising trends where the interested experts should find the ways of solving the problem of building affordable residential housing for different population groups under the conditions of hyperdense urban environment. Steel having high strength than that of the ordinary construction method.Modular construction is required less man power and at the same time skilled labourers are required. Using E-tabs software an modular building is easily analysed,And also is an innovative approach to the developing world.

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