A Background Study on Plain Wall System

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***Abstract*—Plain wall system is a system suitable for use in the field of high rise building where the main load resisting system is in the form rigidly connected wall slab member. Concrete vertical walls may serve both architecturally partitions and structurally to carry gravity and lateral loading. Moment transfer of joint is an important aspect for proper structurally functioning of plain wall system. Hence, the main aim of this study is to review literature from other researchers on plain wall system.**

***Index Terms*—Plain wall system, high rise building and moment.**

I. Introduction

Low cost housing is always relates to the effective budgeting by adopting techniques which help in reducing the cost construction through the use of locally available materials along with improved skills and technology without sacrificing the strength, performance and life of the structure.

For high rise building, the repetition usage of formwork is almost a necessity to optimize construction speed of cast in place technology. Plain wall system is a system suitable for use in the field of high rise building where the main load resisting system is in the form of rigidly connected wall-slab. Fig. 1 shows the plain wall system. Based on Suk et al [1] since the mid-1980s, approximately 4,160,000 apartments have been built in Korea, and more than 70 % of these apartments were high rise apartments having 11 floors or more. While the top of a building is above a degree, the dynamic behavior of high rise building is parallel to a beam with several lumped masses. The vibration problem of high rise buildings subjected to certain dynamic loadings, such as earthquakes loads or wind loads. In traditionally way of construction high rise buildings are use masonry cladding and had heavy internal partitions which added a significant amount of strength and stiffness to the primary load-bearing components. This type of structural arrangement influenced the dynamic response of the buildings through increased mass, stiffness, damping and limited their attainable heights.

Plain wall system is also sometimes called box system or jointed wall-slab structural system. Plain wall system is highly suitable to be used with reinforced concrete as its building material. Some of the advantages of plain wall system are minimizes wastages and cleaner construction site which will lead to easier site management and environmental friendly. Besides, plain wall system which is composed only of reinforced concrete walls and slabs has been widely used in many countries since this type of structure not only can facilitate construction speed but also can reduce the construction cost with the use of suitable and repetitive system formwork.

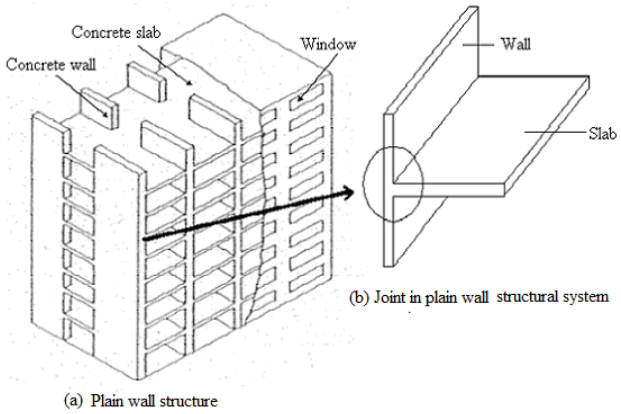

Fig. 1. Plain wall system.

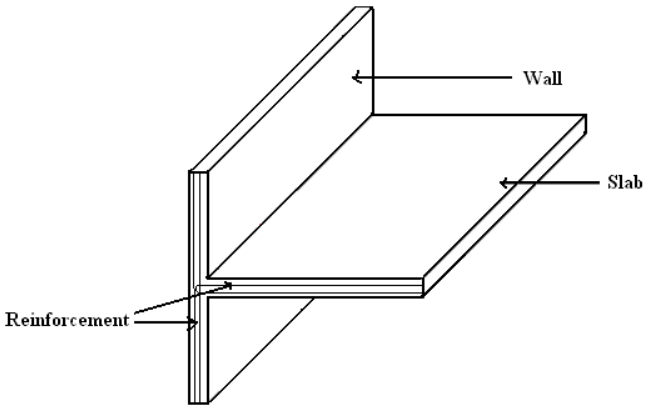

Fig. 2. Joint of plain wall system.

For plain wall system, the vertical element i.e. concrete wall is designed to carry the load transfer from slabs. Since wall-slab is rigidly connected through proper casting, a wall-slab structural system is expected to behave differently in terms of stiffness with respect to lateral force. Proper understanding of strength and stiffness of joint is crucial for the design and analysis of plain wall system. Among the factors, the reinforcement details play an important role, since concrete has negligible tensile strength.

II. Plain Wall System

In concrete high rise building, the repetition in the use of formwork is almost a necessity to optimize construction

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speed of cast in place. In this case, one of the most suitable building system will be the use of plain wall system. In this system, floor and wall forms are attached to a unit consisting of deck, and wall surface, adjustable jack and supporting formwork. For stripping, the whole form is lowered by the jack, slipped out of the slab and shifted to next floor. Fig. 2 shows the joint in plain wall system including the reinforcement.

Harrison et al [2] have carried out a study on a modified stiffness matrix for an interconnecting beam. It includes a rigid arm at each end to allow for this finite distance, rotational springs to account for the localised deformations which take place in the zones where the beam adjoins the shear walls and transverse shear springs to allow for shear deformations in the beam. The matrix is presented in a form which permits existing computer programs to be modified with ease. The results are presented to show the importance of the rotational springs to the accuracy of the mathematical model and are compared with experimental evidence. Aydogan and Akoz [3] have suggested a numerical approach which is used to define the elastic rotational stiffness of a typical joint on the top beam of a prefabricated reinforced concrete gable frame structure. The 12 degrees of freedom triangular plane stress finite element developed is used to examine the connection region. Using this joint rotational stiffness value, it is reported in the paper that realistic results are obtained in the frame analysis. Experimental verification is performed by means of the photoelastic method. Following the proposed method, an effective joint length with reduced moment of inertia is defined using this concept the frame solution is simply achieved, including the existence of joint. Kim and Lee [4] have proposed an efficient computational method to analyze the building with large number of elements especially when rigid floor diaphragm assumption is not used. They have proposed the substructuring technique and matrix condensations technique to analyze the structure with large number of element. They found that these methods will lead to drastic reduction in the computational time and memory space. In year 2003, Kim and Lee [5] have proposed to use the super element matrix condensation technique to analyze the shear wall with opening compared with using finer mesh finite element models for an accurate analysis of "Wall-Slab System". In their study, they found that the outstanding accuracy in analysis could be achieved with drastically reduced computational time and memory. Yeoh [6] has carried out comparison between behaviour of wall-slab structural system and that of conventional moment resisting frame. In his work, joint of wall-slab structural system has been assumed to behave as rigid joint. In practice, rigidity of joint is closely influenced by design detail of the joint. The work has strongly recommended the consideration of the flexural stiffness of the floor slabs in the analysis of "Wall-Slab System". Coupled shear walls have been the subject of many experimental and analytical investigations in the last twenty-five years, resulting in a voluminous literature that dealt with standard and special shear wall problems. Smith [7] modified the wide column frame approach for interconnected symmetrical shear walls by devising an equivalent frame model in which the wide column beams are replaced with beams that are flexible over their whole span between column axes. Flexural properties of the replacement beams are related to the those of the prototype by a simple formula. Chan and Cheung [8] proposed special rectangular plane-stress wall elements with any number of nodes on two parallel sides of the element, to be used in modeling coupled shear walls. These elements were applied in a linear elastic analysis of shear walls in which the spandrel beams and openings were treated as a continuum. Cheung [9] described a finite strip approach to the analysis of walls and wall-frame assemblies. Spandrel beams between the walls could be treated either as discrete elements or as an orthotropic medium with equivalent elastic properties.

As mentioned earlier, behaviour of joint in wall-slab system is crucial for proper functioning of the system. Some researchers have studied on different types of connections, such as timber and steel connection. Quenneville and Erki [10] have studied the moment-rotation behaviour of full-size warren truss timber connections. Sing et al [11] have investigated the moment resistance of steel I-beam to concrete-filled tube column uniplanar connections under monotonic static loading. Silva et al [12] have predicted the behaviour of rectangular hollow sections composite joint, corresponds to an assessment of the initial stiffness of the joint. Liu and Abdhassan [13] have studied moment-rotation parameters for composite shear tab connections in steel frame buildings. Arlekar and Murty [14] have used finite element analysis of 18 strong-axis steel welded beam-column subassemblages with connection reinforcement. Lee and Darry [15] have studied the use of internal ring stiffness to enhance the strength of tubular joints. Liu et al [16] have studied the effects of the inner and outer stiffeners and splice plates jointed with high-strength bolts on the stability bearing capacity and the failure mode of the steel box column and an axial compression model tests have been carried. The experimental results show that the steel box column was destroyed due to the whole bending instability. The splice plates located at the high-strength bolts buckled and accompanied by the whole steel box column's bending instability.

However, it was found that many researches were studied based on steel connection and lack of study on jointed plain wall system.

III. Discussion and Conclusion

Detail in experimental and computation investigation on the behaviour of joint in a plain wall are necessary. Through literature search, it is found that experimental works carried out on joints of plain wall are still lacking. Experimental data on bending capacity provides important input in the process of analysis. There is a need to carry out a basic study on the effect of reinforcements details both in the wall and slab parts of the joint of a plain wall system by means of experiment study.

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