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Research/Technical Note

Analytical Investigation of the Effect of Brick Partition Wall on Building Frame

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Abstract: Structural analysis of building frames represents an important field of application of digital computers to use stiffness approach in order to evaluate their complete stress and deflection behavior. Generally a frame is analyzed without the presence of brick wall in the frame. In the present study, if the brick walls present in the frame whatever the variation of reaction, bending moment, shear force, displacement or deflection of the frame which is then compared to the frame without the brick wall. In the present investigation a five storied building frame has been analyzed under various load combinations. From the frame analysis, it has been investigated that if no nodes of brick wall are coincide with the nodes of beam and column then whatever its effect on moment, reaction, shear force, displacement or deflection. This type of building frames are highly undesirable in lateral loads and also in seismically active areas because in this case there are no connection between the brick wall and the beams and columns, and due to this reason the building frames which have consistently performed very poor behavior and cracks may occur under the beams and also at the side of partition wall. In another case, if a brick wall node is coincided with beam and column nodes then its effects on the results are measured. The whole work has been performed by using computer software STAAD-PRO from which different parameters are computed. If there are well connections between beams and brick nodes, it increases the stiffness of the structure. This reveals significance of frame analysis which provides an accurate and economical solution. A good agreement between the values of various force functions given by approaches is exhibited. It is found that regular system of bays and same length and thickness of connecting beam is favorable for reducing deflection in partition wall. If there are proper connections among the brick walls and the beams and also with the columns than the deflection will be decreased and Stiffness will be increased.

Keywords: Modeling, Building Frame, Stiffness, Staad. pro, Deflection

1. Introduction

A partition wall is a wall that separates rooms, or divides a room. Partition walls are constructed of many materials, including steel panels, bricks, blocks of clay etc. It is the load bearing or non-load bearing wall [1]. A Load bearing partition wall is called an internal wall. For a load bearing internal wall, strength is an important factor of design. For taller and more slender buildings the structural factors become more important and so it is more necessary to choose an appropriate structural form [2]. In addition to satisfy nonstructural requirements, the principal objectives in choosing a building's structural form is to arrange to support the gravity, dead and live load and to resist at all levels the external horizontal load and shear, moment and torque with adequate strength and stiffness. These requirements should be achieved as most economically as possible [3]. The reliability and accuracy of various methods of structural analysis used to analyze multistoried buildings are dependent on the basic assumptions used. Structural analysis comprises the set of physical laws and mathematics required to study and predicts the behavior of structures. Structural analysis can be viewed more abstractly as a method to drive the engineering design process or prove the soundness of a design without a dependence on directly testing it [4]. In this study, a first-order analysis, in which equilibrium and kinematic relationships are taken with respect to the undeformed geometry of the structure, is simple to perform but is not a thorough analysis since it neglects additional loading caused by the deflection of the structure. For most structures, a second-order analysis, which imposes equilibrium and kinematic relationships on the deformed geometry of the structure, is required for stability analysis [5].

To perform an accurate analysis a structural engineer must determine such information as structural loads, geometry, support conditions, and materials properties. The analytical results are further compared with the corresponding results obtained by Staad. pro. Advanced structural analysis may examine dynamic response, stability and non-linear behavior. The frame analysis has been found that if no nodes of brick wall are coincide with the nodes of beam and column then its effects on the results are measured which is performed using Staad. pro [6]. If there are well connections between beams and brick nodes, it increases the stiffness of the structure and also decreases the deflection of the nodes and joints. This reveals significance of frame analysis which provides an accurate and economical solution. The aim of analysis is the achievement of an acceptable probability that structures being designed will perform satisfactorily during their intended life [7].

The objectives of this study are to study the behavior of partition wall on building frame and also determine the variation of shear force and bending moment of different beams and columns. And then study the effect and variation of deflection and other behaviors of the structure. At last make a comparative study of various investigations stated above to have a clear idea about the effect of partition wall.

2. Modeling in Staad. pro

2.1. Properties Assign

A material's property is an intensive, often quantitative, property of some material. Quantitative properties may be used as a metric by which the benefits of one material versus another can be assessed, thereby aiding in materials selection. A property may be a constant or may be a function of one or more independent variables, such as temperature [8]. Material properties often vary to some degree according to the direction in the material from which they are measured and finally a condition referred to as an isotropy. Materials properties that relate to different physical phenomena often behave linearly (or approximately so) in a given operating range [9]. Modeling them as linear can significantly simplify the differential constitutive equations that the property describes. There are two types of material property used while modeling in staad. pro which are concrete and brick properties.

The material properties of brick masonry and concrete which have the most significant effect upon structural performance of the masonry are compressive strength and those properties affect bond between the unit and mortar, such as rate of water absorption and surface texture [10].

2.2. Structural Modeling

For the analysis work, structural modeling was done. A symmetric model was prepared which is the combination of beam, column and brick wall as partition wall. At first a frame was prepared then its fill with brick wall when proper connection have present between the beam and column. Then lateral load as well as vertical load is applied and bending moment, shear force, deflection was observed. After that, another model was prepared which have no connection between the beam and the brick wall node. Then same load is applied like as previously applied load and variation on result was observed. Finally the result of both cases was compared in tabular form and the effect of partition wall (Brick wall) was observed and compared. To perform the analysis using staad. pro there are four stages- Prepare the input file, analyze the input file, Watch the results and verify them, Send the analysis result to compare the SF, BM and Deflection.

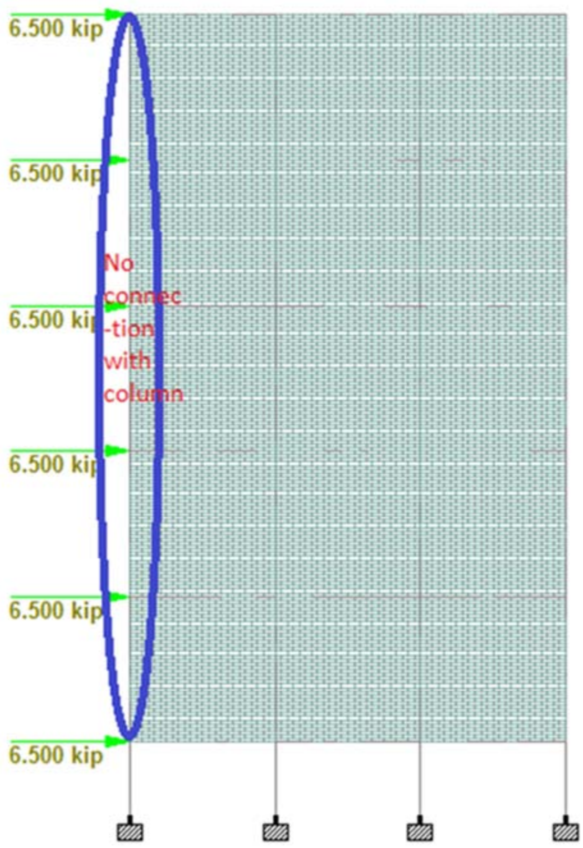

Figure 1. *Partition wall on building frame but there is no connection at left side with column.*

2.3. Building and Load Description

Considering a symmetric (2D) frame, which have three bays. The length of each bay is 10ft and it is a five storied building. The height of each floor is 10ft. Length of each column below the Grade Beam (GB) = 60 inch. Length of each column above the Grade Beam (GB) = 120 inch. Length of each beam (girder) = 120 inch. Cross section of each beam=15inch*15inch. Cross section of each column =

15inch*15inch. Thickness of partition wall = 5inch. Size of brick to be used = 10inch*5inch*3inch. Considering load to analysis this building frame are Self-weight of the structure, Uniformly Distributed Load (UDL) = 1 kip/ft. Lateral load on the joints of beam and column at left side in Global X-Direction as a concentrated load = 6.5 kip (using BNBC art. 2.4.6.4).

3. Results and Discussion

Case: When no connection between brick wall and column at left side then it is compared to the well-connected brick partition wall and column.

Table 1. *Comparison of bending moment (3rd floor).*

Beam no (Floor no.)	When beam and brick nodes have well connection		When beam and brick nodes have no connection at left side		(%) of change of moment at left end	(%) of change of moment at right end
	Left end moment k-in	Right end moment k-in	Left end moment k-in	Right end moment k-in		
22 (3rd)	143	188	100	146	30.069	22.34
23 (3rd)	301	333	229	262	23.920	21.32
24 (3rd)	315	348	244	278	22.539	20.11
25 (3rd)	180	227	137	185	23.888	18.50
26 (3rd)	265	266	179	190	32.452	28.57
27 (3rd)	261	303	192	233	26.436	23.10
28 (3rd)	257	342	183	258	28.793	24.56

In the table 1, which shows the Comparison of bending moment at 3rd floor When beam and brick nodes have well connection and When beam and brick nodes have no connection at left side and finally showing the percentage change of bending moment at both left and right end.

Table 2. *Comparison of shear forces (3rd floor).*

Beam no (Floor no.)	When beam and brick nodes have well connection		When beam and brick nodes have no connection at left side		(%) of change of shear force at left end	(%) of change of shear force at right end
	Shear force at left end. k	Shear force at right end. k	Shear force at left end. k	Shear force at right end. k		
22 (3rd)	9.26	2.76	2.05	2.05	77.861	25.72
23 (3rd)	5.28	5.28	4.09	4.09	22.537	22.53
24 (3rd)	5.53	5.53	4.35	4.35	21.338	21.33
25 (3rd)	3.39	3.39	2.68	2.68	20.943	20.94
26 (3rd)	3.25	5.59	1.9	4.24	41.538	24.15
27 (3rd)	3.53	5.87	2.38	4.72	32.577	19.59
28 (3rd)	3.82	6.16	2.5	4.84	34.554	21.42

Table 3. *Comparison of deflection (5th floor).*

Node no. (Floor no.)	When Beam and Brick nodes have well connection		When Beam and Brick nodes have no connection at left side		% of change of horizontal displacement
	Horizontal, in	Vertical, in	Horizontal, in	Vertical, in	
25 (5th)	0.628	-0.003	0.505	-0.002	19.585
26 (5th)	0.627	-0.022	0.503	-0.022	19.776
27 (5th)	0.626	-0.023	0.503	-0.023	19.648
28 (5th)	0.626	-0.028	0.502	-0.028	19.808

Similarly in above, the table 2 and table 3 shows the Comparison of shear forces at 3rd floor and Comparison deflection at 5th floor When beam and brick nodes have well connection and When beam and brick nodes have no connection at left side and finally showing the percentage change of shear forces and deflection at both left and right end.

The above figure 2 shows bending moment of three beams. It presents that, in case of well connection beam 5 has more than 400 kip-in BM and no connection brick-column node has less 400 kip-in BM. And Beam 6 and 7 also shows same character. So when well connection among brick and beam nodes is present in this case the bending moment is more than that of the no connection of brick wall with column at left side.

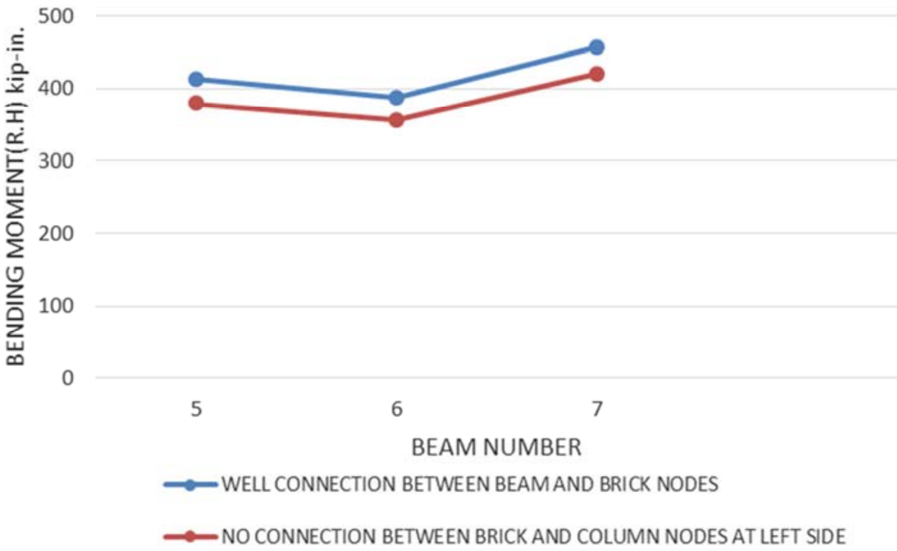

Figure 2. *Showing the variation of bending moment when well connection among brick and beam nodes and also no connection with column at left side.*

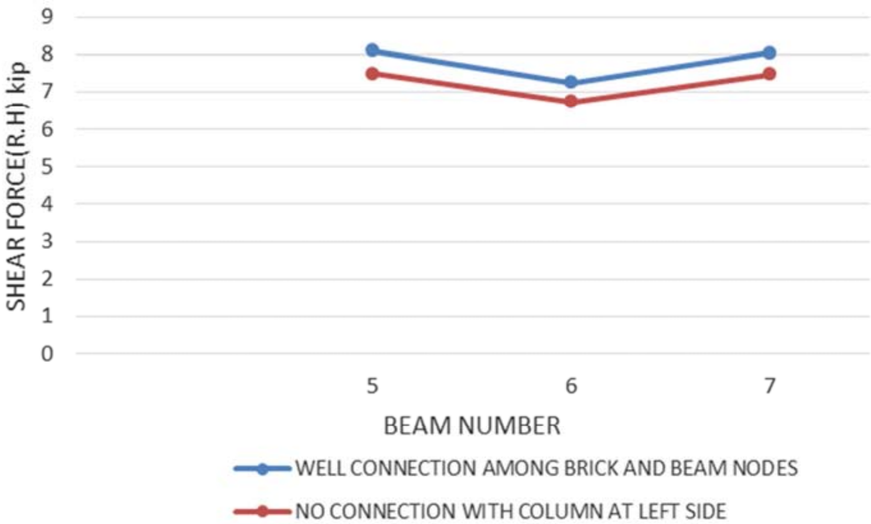

Figure 3. *Showing the variation of shear force when well connection among brick and beam nodes and also no connection with column at left side.*

The figure 3 indicates shear force of three beam nodes. It presents that, in case of well connection beam 5, 6 and 7 has around 8 kip shear force and no connection brick-column node has around 7 kip shear force. So when well connection among brick and beam nodes is present than the shear force is more with respect to the no connection of brick wall with column at left side.

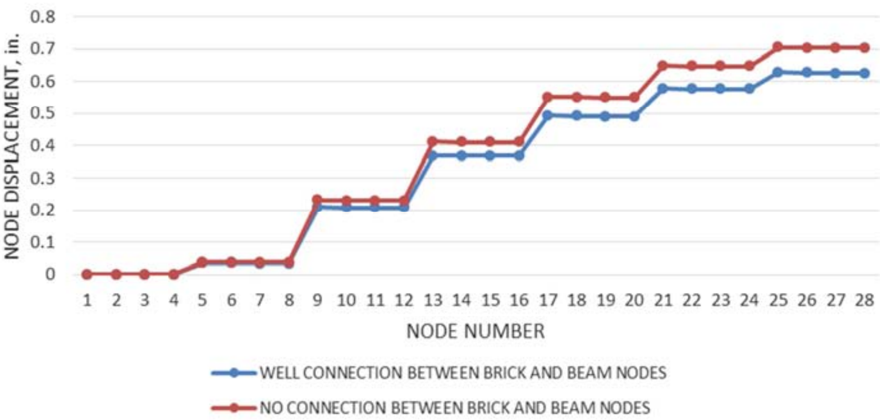

Figure 4. *Showing the variation of displacement when well connection among brick and beam nodes and also no connection with column at left side.*

In case of displacement, it shows opposite character with respect to the bending moment and shear force and the figure 4 reveals that, when well connection among brick and beam nodes is present the node displacement is less than the no connection of brick wall with column at left side.

4. Conclusion

The behavior of partition wall has been investigated by "STADD PRO" software. Form the analysis the following conclusions can be drawn

i) It is found that there are proper connections among the brick nodes and beam nodes have present, no cracks will be developed under the beams of the structures in the partition wall. Due to considering the stiffness of partition wall bending moment decreases (10% to 35%).
ii) It is found that proper connection among the brick nodes and column nodes have also present, no cracks will be visible at the side of the partition wall of the structures.
iii) It is found that regular system of bays and same length and thickness of connecting beam is favorable for reducing deflection in partition wall.
iv) Deflection depends on the geometrical parameters. Deflection increases with the increase of openings.
v) It is found that proper connection among the brick wall and the beams and also with the columns have present deflection will be decreased significantly (4% to 20%).

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