CHAPTER I

INTRODUCTION

1.1 Statement of the Problem.

A multistory building frame consists of not only the frame but also a set of exterior walls and partitions which define the useful space and were divided according to its use. Normally, an infill panel of the building such as brick wall is not taken into consideration for the strength of the building frame, even it shows remarkably stiffer than the ordinary one. It is appropriate to consider a wall as an extra strength of a building frame, especially to resist lateral loads caused by wind or earthquakes.

When a non-integral infilled frame is subjected to a lateral load, the frame and infill always separate over a large portion along the length on each side and regions of contact remain only at adjacent to the corners of the compression diagonal. Therefore, as a rough approximate, it may be assumed that the infill behaves as a diagonal bracing strut. If values for the diagonal stiffness and strength of the infill could be determined, it would be possible to predict the lateral stiffness and strength of the infilled frame.

1.2 Research Objective and Scope.

The objective of this research is to develop a method to predict strength and lateral stiffness of the infilled frame by approximate method and to study a resonable mathematic model for the strut analogy.

A numerical method of finite element technique is employed to determine an equivalent diagonal strut in terms of the effective width. In the finite element analysis, it is assumed that a non-integral brick infilled panel is subjected to triangular distributed loads over the contact lengths. The infill panel is divided into several four point rectangular elements with constant thickness, and then the finite element techniques are applied to solve for the stresses and nodal displacements. By employing the fundamental of strength of material, an effective width of adiagonal equivalent strut can be found.

Several experimental investigations (2, 24) as well as some other methods of analysis (1, 2, 3, 15, 16, 17, 18, 19, 20, 22, 23) were compared to the method proposed in this study.

The scope of the study has been limited to

(1) The building bricks constructed in the reinforced concrete frame.

(2) The solid wall where no opening is permitted.

(3) The span length to height ratio in the ranges of 1 to 2.

Several assumption has been made as

(1) Brick infill is considered as an isotropic material.

(2) Brick infill does not integrate with concrete frame.

(3) Self weight of the wall is neglected.

(4) The arrangements of brick-work are running bond.

1.3 Literature Review.

Experimental investigations have been conducted by several researchers to study strength and rigidity of masonry shear walls both with and without bounding frames.

Polyakov (29), the first major investigator of infilled frames at Central Research Institute of Industrial Structures in Moscow found that the usual mode of failure of complete infill was cracking of the mortar joining along the compression diagonal. The infill stress was analyzed by an approximate method, using a stress function to express the stress distribution around the boundary.

Whitney, Anderson and Cohen (36), presented a paper on designing of one-story reinforced concrete portal frames with filler walls. The elastic behavior and the strength of these frames were determined by assuming the infills act as vertical cantilever beams with fixed base.

Benjamin and Williams (1) studied the effect of brick walls on boundary structural steel frames and reinforced concrete construction subjected to lateral forces. They concluded from their limited study by means of model tests that plain brick walls had significant strength when confined by bounded frame and the behavior of infilled frame could be predicted approximately by the method of elementary strength of materials.

Satchanski (16) tested full scale infilled frames with and without opening in the wall in elastic range and the infilled frame was considered as a problem of plane stress. He utillized theory of elasticity to analyze on infilled frames behaviour and also proposed a method to analyze any type of infills by introducing various correction factors.

Holmes (3) first proposed an equivalent strut theory for infilled frames. The infill may be considered as a diagonal compression or braced member in the frames, therefore it can be replaced by an equivalent diagonal strut with uniformed thickness, should equal to one-third of the panel diagonal. The failure of the infilled frame, according to his study, depends on the ultimate strain of the infill. His theoretical investigation was followed by a series of full scale tests using steel frames with various infills. The experimental results showed a good agreement with theoretical failure load. Another test (4) was conducted to determine the behavior of single-story infilled frames subjected to horizontal and/or vertical loadings and two-story infilled frames subjected to horizontal loading. Those tests were concluded that the multi-story frames could be predicted satisfactory by a modified method for single-story frame analysis.

Stafford Smith (17) agreed with Holmes on equivalent strut concept but not on the one-third rule. He found that separation at the interface between frame and infill was concentrated around the loaded corners of the infill. He stated that the stress distribution in the infill and therefore, affects its strength and modes of failures. In stead of one-third rule, he considered the relative stiffness of frame and infill as a parameter for determining width of an equivalent strut. He extended his theory to rectangular infilled frames.

Malaivongs (2, 24) investigated plain brick walls and brick infilled square steel frames. Local bricks were used as infilled materials. The test results of the structural behavior of infilled frame were compared satisfactory with the theoretical results in which the equivalent strut theory was used. He concluded that an equivalent strut area as suggested by Holmes (3) yield higher predicted loads for bounding steel frames of relatively low stiffness but gave better results for steel frames with higher stiffness. However, he found that the effective width of the strut suggested by Smith (17) gave more conservative predictions.

Tongpatankul (24) studied behaviour of brick infill of reinforced concrete frames with various span length to height ratio. This limits for L'/h' = 1.0, 1.5 and 2.0 and using local brick called Mon-brick as infilled brick. Holmes and Smith methods were used to predict lateral stiffness and ultimate load and then compared with his model test. He concluded that Smith's (17) suggestion for the effective width of the equivalent strut gave better prediction for ultimate load and Holmes method gave better prediction for stiffness.

Benjamin (2) had studied lateral stiffness of rectangular brick infill of reinforced concrete frame. His analysis employed a finite element method for predicting lateral stiffness and then comparing the result with model test. The stiffness obtained from theoretical analysis gave higher values than the test ones up to 100 % , because he neglected the effect of separation between infill and the bounding frame in his analysis.

Meli, R (22) studied behaviour of masonry walls by full scale tested of the panels subjected to one direction lateral loads and to alternating lateral loads. He described his experimental behaviour that walls in concrete frames behaved as monolithick elements for small loads until separation occurred in the lower tensile corner and later also in the opposite corner. Major stiffness reduction was due to progressive flexural cracking in the frame or in the wall itself. He also found that the increase lateral stiffness due to pre-compression with vertical load. This result was limited to vertical load not exceeding one third of the wall capacity. He suggested to calculate the lateral stiffness with reasonable accurate by combining the flexural stiffness of the frame on the basis of cracked transformed section and the shear stiffness of the infill.