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In-Plane Behavior of Masonry Infilled Reinforced Concrete Frames with Wooden Choh-kat Openings

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Abstract- Determination of the behavior of infilled framed structures with openings has been a matter of study lately. However, analysis of infilled structures have of yet ignored the vital effect of opening frameworks, which in Kashmir valley is a wooden assembly called 'Choh-kats'. This study focuses on study of the behavior of the infilled frames with wooden 'Choh-kats' under in-plane lateral loads and is based on determination of initial lateral stiffness of infilled frame with wooden choh-kat under control parameters of opening location, opening area, opening aspect ratio and model of choh-kat framework. The finite elements are used to illustrate the behavior, and linear stiffness of the frames is determined at 10% lateral strength of a fully infilled frame. This work illustrates that the in-plane lateral stiffness of the frame increases with the addition of choh-kat and also gives a better understanding of illustrating infill with choh-kat openings as multiple compressive struts.

Keywords-Brick infills,finite element method, lateral stiffness, wooden choh-kat.

I. INTRODUCTION

Brick masonry reinforced or un-reinforced is generally used as an infill material dating back to 18^{th} century when steel frames were used. Modern framed structures are assembly of columns and beams constructed in reinforced concrete or steel. The bare frames have no infill while the infilled frames are generally filled in masonry. Bare frames would behave as framed systems that generate moments and axial forces. This is particularly the case under an action of in-plane lateral forces [1]. Under an action of in-plane lateral forces, infilled frames behave monotonically with the framed system up to the stage the infill shows corner separation at 2% lateral in-plane drift [2]. At this stage the system shows maximum stiffness, this tends to decrease with further increase in loads due to infill tensile crack initiation.It is at this moment that the infill behaves as an axialdiagonal compressive strut [3]. For in-plane lateral loads, a simple mathematical infill representation is a diagonal compressive strut pin-jointed at junctions [4]. Equivalent width of this strut is taken as 1/3 of its diagonal length [1], 1/8 of diagonal length [5], 1/10 of diagonal length [6], ¼ of diagonal length [7]. Infill is also modeled as three parallel struts with width of diagonal strut 1/8 of diagonal length and two off-diagonal struts as 1/16 of diagonal length [8]. Polyakov suggested that the strut displacement occurs at corners and stresses are transmitted in compression zone of frame-infill interface. Thereby, contact length which depends on the stiffness of frame and infill is determined by various methods [9].

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Studies on infilled frames have suggested that the presence of an infill leads to increase in the in-plane stiffness up to 500%, increase in strength by 70% and in increase in energy dissipation capacity by 100%, besides changing the seismic behavior of the system [10].

Opening in an infill is a perforation produced due to presence of a door, a window or a ventilator. The purpose of opening is to allow light as well asventilation. Under gravity loads, the behavior of infill is as piers and spandrels around openings. An infill with an opening under an action of in-plane lateral loads does not behave as an axial compressive strut but as multiple struts. With this, lesser chances of corner separation is induced, possibility of which decreases further with increase in opening area and deviation of aspect ratio about unity. Thereby, maximum in-plane lateral stiffness decreases expectedly with increase in the area of an opening [11]. There is an absence of knowledge of contact length parameters. The perforated infill is difficult to model. For this purpose, the effective width of a diagonal strut for infilled frame without opening may be reduced by a reduction factor to simulate the presence of openings of various aspect ratios in the infilled frame [12-14]. Multi-strut models are also suggested to simulate the local effect due to presence of an opening [15]. Mesh modeling of a perforated infill suggests the mesh to be broken at the junction of the opening and the infill.

However, all works prior have not incorporated the main component of the opening about which a shutter of a door or a window is hinged. This is the opening frame and this frame in sub-tropical and temperate regions of the world is made in wood. In *valley of Kashmir*, where traditional construction was either dhajji-dwari or taq, *choh-kat frame* constructed in wood was an essential component. This choh-kat frame has found its presence in modern infilled construction as well. In many contemporary constructions, the wooden choh-kat has been replaced by Aluminium or steel frames. It is observed that these wooden choh-kats are partially embedded in infill masonry by means of steel hold fasts or flats. Choh-kat is a monolithic construction with masonry infill apart from frame-infill construction which is not so. The behavior of masonry infill will change from the system without choh-kat. With consideration of choh-kat in a masonry infill, the possibility of infill corner separation and of axial diagonal compressive forces transmitted through infill seem to increase, which is however, not the area of this study.

II. OBJECTIVES

This study focuses on determining the *initial lateral stiffness* of infilled reinforced concrete frame with wooden choh-kat. The initial lateral stiffness is the stiffness at the load when infill and frame behave monolithically.

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