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Evaluate Performance of Precast Concrete wall to wall Connection

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Abstract

The building industry keeps growing towards industrialization in construction by implementing Industrialized Building System (IBS). The components of IBS Structure which are floors, walls, columns, beams and roofs are assembled and erected on the site by properly joints to form the final units. The present study deals with the evaluation of precast wall connections subjected to inplane lateral ground movement. For this purpose, 3D finite element model of precast walls and connection is developed using finite element model. The interaction between casting concrete and precast concrete as well as reinforcements and concrete is modelled with nonlinear stress-strain behavior, to consider the yielding of steel and concrete. The model was subjected to lateral ground movement and the performance of connection is evaluated in terms of the stress, deformation and absolute plastic strain.

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1. Introduction

Nowadays, much more consideration paid out to industrial building systems (IBS) as opposed to prior.

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Actually challenge achievement period would be the cut-throat element between many firms. Indeed, the improvement of new technologies and engineering, new structural systems and material result in evolution in industrial construction [1].

Many countries try to develop the industrial building systems. In the United Kingdom, Modern Methods of Construction (MMC) are defined as technologies that provide efficient strategy to prepare more production with minimum time. It includes prefabricated methods, off-site production and offset manufacturing for the building[2]. In Malaysia the term of Industrial Building Systems (IBS) is used for a process of producing an element in a controlled environment condition, transportation, and erects the members on main place [3].

Industrialized building system is the term to represent the concept of prefabrication and it has been widely used as a common understanding by researchers [3-6]. The most common applications of precast concrete members associated with building construction are walls. Precast concrete walls provide an excellent function for low to medium rise commercial and industrial buildings. They are relatively easy to manufacture, efficient, durable, and desirable. The biggest challenge is the behaviour and possible failure of the connections under severe lateral loads against earthquake or wind excitations [7-10]. Various types of precast connections have been studied by different researchers. Birkeland found out that to avoid damages, all potential failure planes must be crossed by steel. In precast work, these planes may be either between elements, or inside an element. For the former, the connection itself must provide the necessary strength. For the latter, the steel is usually rebar, for which it is essential that adequate anchorage be provided on both sides of the potential failure plane under consideration [11].

The most important part of the precast concrete wall is connection between two walls, which ensure the continuity of load transferring of the precast wall system. Waddell claimed that connections or joints are implemented in IBS structure for connecting precast components to each other and also to connect precast components to the structural frame such as cast-in place concrete, steel, or masonry [12]. Chakrabarti and et al, Figured out that although the horizontal joints at the floor levels considered as a weak link in the structural system, they are comparatively much stiffer than the vertical joints because of the normal pressure applied on the joints. It is due to self-weight of the wall panels and other superimposed loads [13]. Frosch studied the connection of discrete concrete elements to each other which is often required in precast construction and realized that the actual shear key settings (alignment as well as spacing) got absolutely no significant impact on the particular peak capability no effect within the residual capability. Furthermore, he found out was affected by relative strength between the grout and panel concrete [14].

Ong suggested that in one-to-one horizontal loop connections, an increase in the loop overlapping length, a decrease in the internal diameter, or an overlap spacing of the loop resulted in an increase in the flexural strength of the precast specimen tested [15]. Al-Aghrabi et al, tested the structural performance of two type of wall-slab connection under reversible quasi-static cyclic loading [16].

Based on the extensive literature, it can be mentioned that most of researchers evaluate different connections; however, most of them simplified the connections in terms of geometry or constitutive model in their simulation. The main aim of this study is to provide the precise behaviour of precast wall to wall connection by considering material nonlinearity and actual geometry of the components against lateral loading.

2. Wall to Wall Connection

In this study the 3 dimension finite element model of precast concrete connection and its interaction with two adjust concrete panels was simulated by the incremental application of the lateral displacement at top side of the left panel. An isometric view of developed model and cross section of the panel and hook geometry are shown in Figure.1.(a). The wall Panels` dimensions are assumed as 1.2m height, 0.6m width and 0.125m thickness. Furthermore, connection of walls which is located in the gap between two panels is 1.2m height, 0.15m width and 0.125m thickness and all are supported on the ground. Hooks length are assumed as