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# Case study of load-bearing precast wall system subject to low seismic intensity by linear and nonlinear analyses

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ABSTRACT

This paper investigates the behaviour of load-bearing precast wall system (namely the HC Precast System – HCPS) subject to seismicity in Malaysia. Recent tremors felt across the country heeded the call for the need of seismic design guidelines to be implemented. For this study, the design ground acceleration for Malaysia has not been finalized. Throughout the years, several schools of thought that occurred among different researchers pertaining to the value of design ground acceleration, ranging from 0.05 g to 0.1 g. The implications of the selected values can be great especially in designing new buildings or retrofitting existing ones. Thus, linear analysis using Modal Response Spectrum Analysis (MRSA) and nonlinear pushover analysis of representative HCPS were performed for this study. The finite element (FE) model focused particularly on the nonlinear behaviour of the interface between a precast wall and cast in-situ column. Prior to the modal and pushover analyses, the FE model was validated against quasi-static cyclic test results of identical precast system obtained from literature. Differences between the MRSA and pushover approaches are presented and discussed. Performance levels of the structural system were subjected to three levels of design ground acceleration (0.05, 0.075 and 0.1 g) have been included.


## 1. Introduction

The government of Malaysia has been strongly encouraging the use of Industrialized Building System (IBS) in the construction industry especially for large projects. The precast concrete method and structural steel are the two major components of IBS. However, the level of acceptance of local contractors in using precast concrete construction is very low [15]. This calls for local precast suppliers to take the initiative to develop their own product lines in order to respond to the call from the authorities. Among them are the HC Precast System (HCPS), which consists of structural wall panels prefabricated off-site. The wall panels are joined at site through wet concreting along the vertical joints (Fig. 1). Instead of using conventional timber formwork for site concreting, the modular mould [15] was invented by the system supplier to improve the reusability as well as to speed up the construction process.

Fig. 2 shows the force transfer mechanism along the vertical interface between the wall panel and the column. While vertical force (i.e. design load of the structure) is mainly resisted by the shear keys, resistance against lateral force depends

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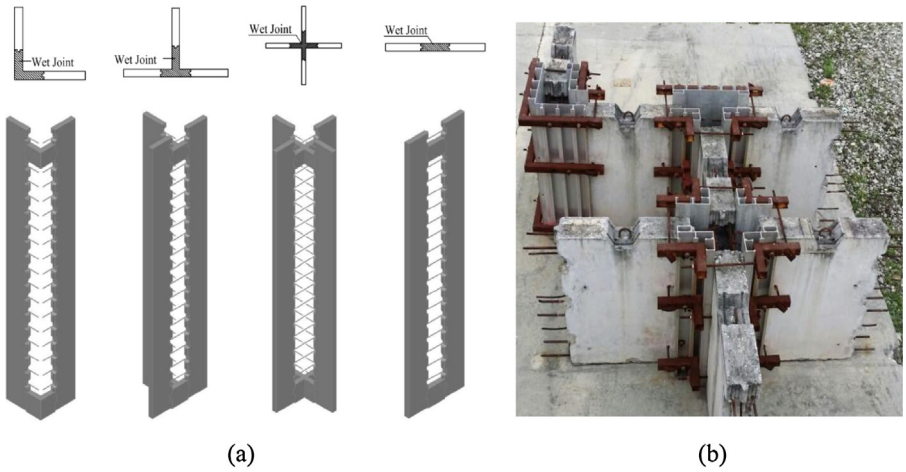


**Fig. 1.** (a) Commonly used joints in HCPS configuration and (b) Reusable modular moulds for wet joint concreting.

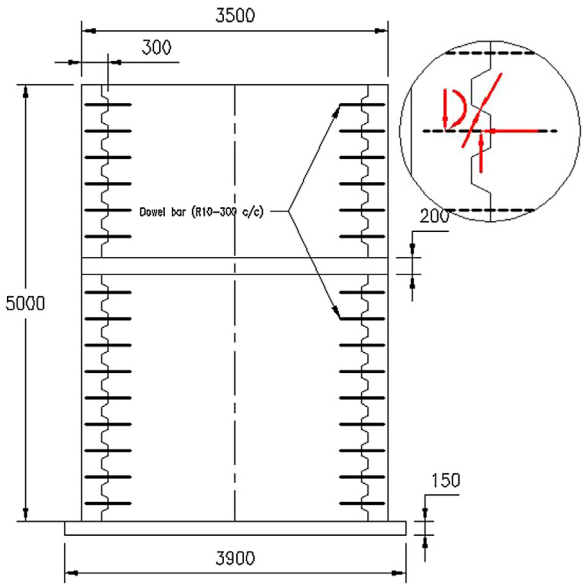


**Fig. 2.** Configuration of shear keys and dowel bars along interface as well as the internal force transfer mechanism at the connections.

on the dowel bars between the two concrete components. Thus, the two governing damage models of the interface can be either shear or crushing of concrete at the shear keys, or pullout of dowel bars.

Although severe seismic incidents are rarely reported in Malaysia, the occurrence of far field seismic effects from the Sumatra earthquakes in recent years has led to awareness by the government to initiate seismic designs in practice. With such effort, the Institute of Engineers of Malaysia (IEM) formed a Technical Committee (TC) concentrating on the formulation of seismic design codes suitable for the community of Malaysia based on Eurocode 8 (EC8) [7].

The early development of seismic hazard maps for Malaysia began in the early 2000s. [1] proposed the deterministic seismic hazard map for Peninsular and East Malaysia for the first time. Different seismic zonation maps were later proposed by [12] using probabilistic seismic hazard analysis. The seismic hazard maps that were developed by [1] and [12] suggested design ground acceleration of 0.1g to be used for a return period of 475 years. Fig. 3(a) and (b) shows the seismic hazard map for Peninsular Malaysia and Borneo respectively. Although these maps have been recommended to the government of Malaysia and have been used in some of the projects, they have yet to be made the official seismic design guidelines for the country. There are several extended works carried out by several other researchers over the years [14,3]. [13] proposed bedrock acceleration of 16.5 and 23.4 gal (1000 gal = 1g) for 10% and 2% probability in 50 years for Kuala Lumpur. The Technical Committee (TC) of seismic code comprising of mostly practicing engineers regarding the proposed design ground acceleration is still of concern whether such level of acceleration will cause major changes to current conventional design of structures. Hence, the TC has proposed 0.05g to be used as the design ground acceleration for normal building structure [8]. Meanwhile,