RC building structures built in the low or moderate seismic risk regions were traditionally designed without any seismic resistance details, which were mainly designed to resist the service loads. Indeed, neglecting the seismic design of beam-column joints imply high sensitivity to potential earthquake risk.

In the regions of low or moderate seismicity, such as in mid-America, the UK and Hong Kong, the seismic risk cannot be negligible although there is a geological advantage as they are far away from the boundary of the plate. Many typical earthquakes, such as the Newcastle in 1991 (EERI 1991), Turkey in 1999 (Sezen 2003) and Wenchuan in 2008, have repeatedly demonstrated that the RC beam-column joints without considering seismic resistance details are more vulnerable.

When the RC frame buildings are subjected to earthquake load, the possible brittleness will be concentrated in the beam-column joints. This is dependent upon not only the flexural capacity ratio of the beam to column, but also the detailing of transverse links in the joint core, which affect significantly the shear strength of the beam-column connection (Scott 1992 and Hegger 2003). It has been shown that severe damage and/or collapse of many RC framed buildings in recent earthquakes is the result of poor reinforcement detailing of the beam-column joints. It is necessary to maintain the integrity of the beam-column joint to avoid the sudden degradation of the brittle failure of the frame structure.

Eccentric RC beam-column joints, which largely required by architectural considerations in practice, were extensively used in existing RC frame structures. The eccentricity, which is formed by the difference in the axis between the beam and the column, generates torsional moment and affects the ductility, shear strength and other seismic behaviours of the eccentric joints. Lawrance (1991), Joh (1991), and Raffaelle (1995) reported that early degeneration of ductility and shear strength was observed in the eccentric beam-column joints with square columns. Teng (2003) indicated that the stiffness and strength degradation was observed when the eccentric joints were subject to cyclic loading. Lee (2007) reported the experimental results which show that eccentricity had negative effects on the seismic performance. Nonetheless, only limited results of non-seismic detailed eccentric exterior joints have been reported in the literature.

In this study, three 2/3-scale RC exterior beam-column joints were designed according to the Hong Kong Code of Practice (HKSUC 2013), fabricated, and tested under reversed cyclic-load. The primary intention of this project is to study the effects of the eccentricity and the stirrup ratio in joints on the seismic behaviour of non-seismic detailed RC beam-column joints subjected to simulated seismic loading. Then, by comparing the experimental results with the predicted values of three seismic and two pre-seismic design codes, which are widely used and include Eurocode 2, HK Code, Eurocode 8, NZS 3101 and ACI 318-14, the effectiveness of the current codes for predicting the shear strength of beam-column joints with non-seismic detailed is evaluated.

2. EXPERIMENTAL PROGRAMME

2.1 Specimens

The geometric dimensions of the three beam-column joints are the same, with the cross-section dimension of the beam is 150 mm × 450 mm and the column is 300 mm × 300 mm. The longitudinal reinforcement of the column is 4T20, and the beam is reinforced with longitudinal reinforcement 2T20 at the top and bottom, respectively. The diameter of the stirrup is 10 mm, and the details are shown in Fig. 1.

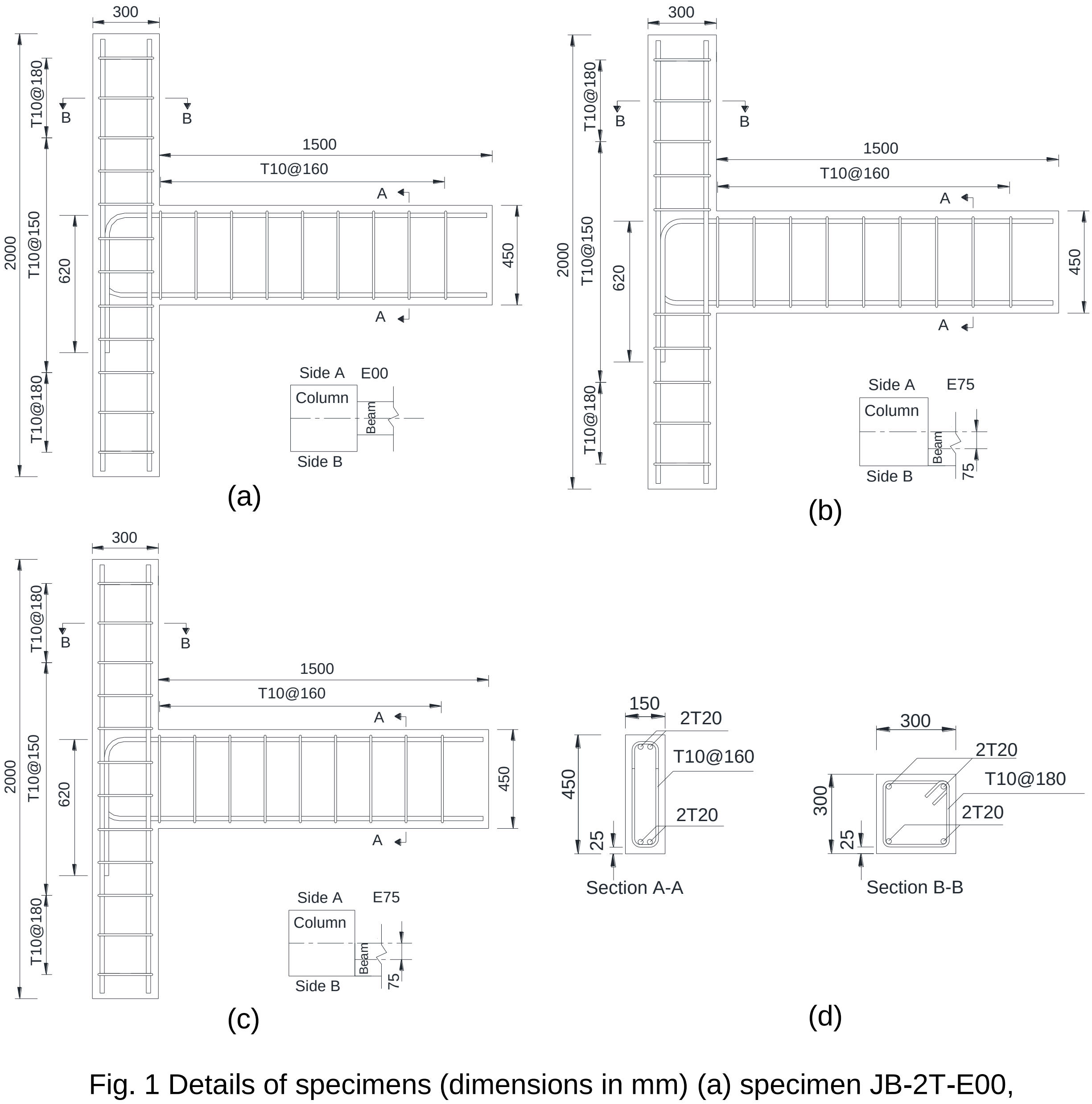

Fig. 1 Details of specimens (dimensions in mm) (a) specimen JB-2T-E00, (b) JB-0T-E75, (c) JB-2T-E75, (d) reinforcement details of beams and columns