SEISMIC BEHAVIOUR OF A CONCRETE-FILLED STEEL TUBE WITH DIAPHRAGM

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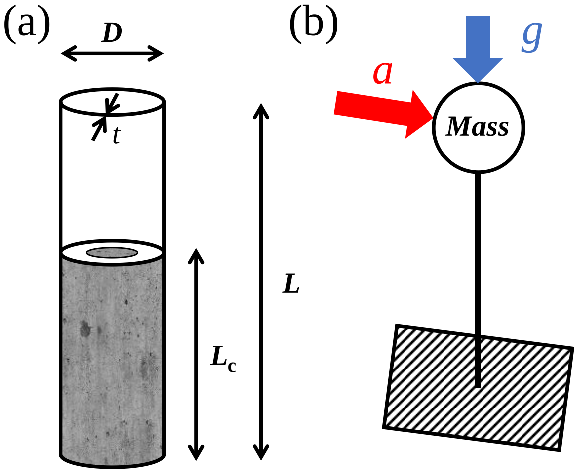
1. Introduction

Concrete-filled steel tubes (CFST) have good strength and ductility performances compared to hollow columns. They are often utilized as the pier of the motorway viaducts. Japan road association recommends that the diaphragm is to be installed on the top of the filled-in concrete to fix the concrete in the steel tube [1]. However, Shimaguchi reported ductility performance of the CFST may become smaller by installing the diaphragm [2]. Therefore, it is necessary to clear the influence of the diaphragm on various CFST behaviour. In this study, authors make the dynamic analysis of CFST with diaphragm focusing on the diameter-thickness ratio D/t, the filling ratio L_c/L, and the concrete strength f_c. Within above results, we discuss the influence of the diaphragm on CFST behaviour.

2. Analytial model

Figure 1 shows the outline of the numerical model with the analytical conditions. Within Figure 1(a), D indicates the diameter, t is tube thickness, L is tube depth, and L_c is concrete height. In this study, we assume the CFST having the various parameters to investigate the effect on the CFST behaviour. Figure 1(b) show the analytical conditions. The bottom part of the CFST is fixed. At the top of the CFST, the mass M was considered to correspond to the superstructure of the viaduct, and the dead load Mg (g = 9.8m/s^2) and the three direction (North-South, East-West, and Up-Down) seismic load a were applied. As the seismic load a, the seismic load observed in the Kobe earthquake was utilized as shown in Figure 2. This earthquake occurred in 1995, and many structures were suffered the serious damage. This earthquake has the major tremor between 2 to 5 seconds, and the maximum acceleration is -8.2 m/s at 2.77 s.

At the interface of the steel tube and the concrete, they repeat separating, contacting, and slipping under the seismic load. These behaviours are modelled as the contact problem as same as the before author's studies [3-4].



(a) outline of the model, (b) analytical conditions.
Figure 1: Numerical model and analysis conditions.

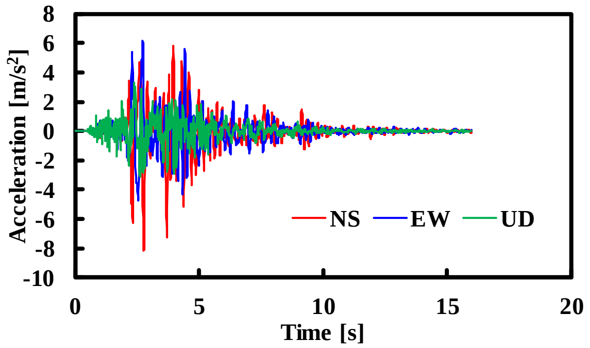
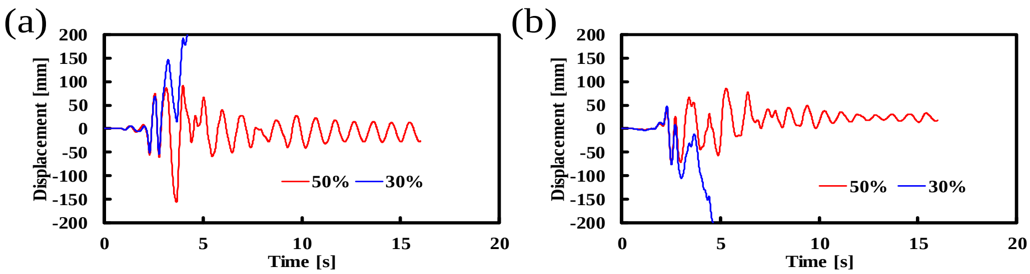


Figure 2: Kobe earthquake.

3. Result

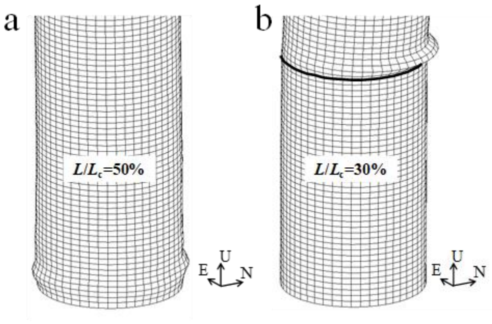
We indicate the behaviours of CFST with difference filling ratio L/L_{C}. Figure 3 shows the displacement hysteresis at the top of CFST. In this figure, the red line indicates the CFST having the concrete height accounts for 50 % of the tube depth, and the blue line the CFST having the concrete height accounts for 30 %. It can be seen that the large displacement arises on the model of L/L_{c} = 30%. Figure 4 shows the final stage deformation shapes of the CFST. In this figure, the buckling deformation is observed at the bottom part of the model of L/L_{c} = 50% of the tube depth. On the other hand, model of L/L_{c} = 30% has the buckling deformation just above the concrete (see black line at Figure 4(b)). These results imply that the large damage arises on the CFST with insufficient L/L_{c}.

The detail results and discussion will be shown during the Symposium.



(a) North-South, (b) East-West.

Figure 3: Displacement hysteresis.



(a) L/L_{c} = 50%, (b) L/L_{c} = 30%.

Figure 4: Final stage deformation shapes.

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