Zeitschrift: IABSE reports = Rapports AIPC = IVBH Berichte

Band: 999 (1997)

Artikel: Column-pile joints made of steel pipes filled with concrete

Autor: Takano, Hideaki

DOI: https://doi.org/10.5169/seals-1094

Column-Pile Joints Made of Steel Pipes Filled with Concrete

Hideaki TAKANO
Civil Engineer
Company Joshin-etsu
Takasaki, Japan

Hideaki Takano born 1955,
Complete the Department of
Junior College Nihon University.

Summary

For a connection of a column and pile made of concrete-filled steel pipes with different diameters, a simple overlap joint in which a smaller diameter pipe is inserted by the specific length to a larger diameter pipe with concrete filled between them has been proposed as an economical and effective joint system. The experiments indicate that the method to predict ultimate loads of the present joints has been proposed.

1. Test Program

As illustrated in Fig.1, cantilevers of concrete-filled steel pipes (CFSPs) having the present overlap joints are loaded at the top of the column.

2. Proposed Model for Prediction of Ultimate Load

Judging from the failure processes of the present joints, it is considered that the bending moment and shear force applied to the column are carried by the couple forces of horizontal bearing pressure and friction developed on the embedded part of the column. Therefore, the authors try to predict the ultimate load of the joints by assuming a load-carrying model illustrated in Fig.2, based on experimental observations of the present tests and finite element analyses previously carried out.

2.1 Balance of moment

From the balance of the moment shown in Fig. 2,

$$M - T\left(\frac{2\sqrt{2}}{\pi}\right)d = -\frac{LP^2}{3(2P-Q)} + (P-Q)\frac{L(5P-2Q)}{3(2P-Q)} \quad \cdots\cdots (1)$$

where M and Q are bending moment and shear force applied to the column respectively, and P and T are resultant forces of bearing pressure and frictional stresses developed on the column respectively. In the above equation, the friction is assumed to be developed on one-forth the circumference of column on tensile and compressive sides respectively.

2.2 Frictional force at ultimate states

The frictional stresses developed between the column pipe and the concrete filled are assumed to be subject to Coulomb's friction criteria. That is;

$$\tau_{\max} = c + \sigma_n \tan\phi \quad \cdots\cdots (2)$$

$\tau_{\max}$: maximum frictional stresses σ_n : normal stresses at the interface

c : cohesion of friction ϕ : friction angle

Then, a resultant force of frictional stresses T is described as follows;

$$T = c\frac{\pi}{4}dL\frac{P-Q}{2P-Q} + \frac{\pi}{2\sqrt{2}}(P-Q)\tan\phi \quad \cdots\cdots (3)$$

2.3 Bearing pressure at ultimate states

The bearing pressure developed on the column is assumed to be determined by shear capacities of the shear panels which consist of the pile pipe and annular concrete in the overlapped part with the length of L. Therefore, the bearing pressure is described as follows;

$$P = V_s + V_c \quad \cdots\cdots\cdots\cdots (4)$$

where V_s is a shear capacity carried by steel pipe and V_c is a shear capacity carried by annular concrete.

The shear capacity of the pile pipe is to be calculated as follows;

When the couple force of bearing pressure is applied to the pile pipe, the tensile force band with the width of 2/3L is assumed to be formed on the lateral panel of the pile pipe in the direction from the center of action of the total bearing pressure on the compressive side to that on the tensile side. At the ultimate states, the tensile force band yields in full. Then,

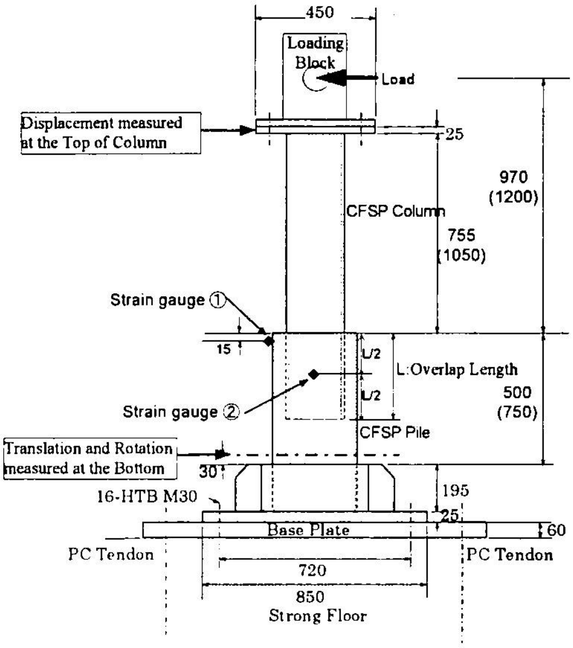

Fig.1 Description of Test

$$V_s = f_y \cdot 2t \cdot \frac{D'}{\sqrt{\left(\frac{2}{3}L\right)^2 + D'^2}}\left(\frac{2}{3}L\right) \quad \cdots\cdots\cdots\cdots (5) \quad \text{where } D' = \frac{\pi}{4}D$$

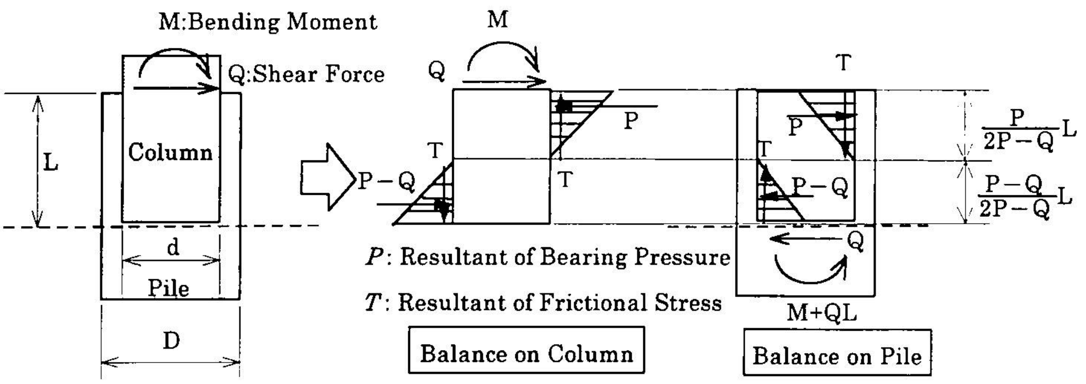

Fig. 2 Load Carrying Model for Predicting Ultimate Loads

On the other hand, because in the experiment the annular concrete was pulled out of the pile pipe, the shear capacity carried by the annular concrete is determined by the resisting force which prevents the concrete from being pulled out.

Therefore, the shear capacity V_c is;

$$V_c = \frac{3\sqrt{2}}{\pi}\frac{D}{L}\left\{\frac{\pi}{4}D\cdot\left[L-(D-d)/2\right]\cdot c - \frac{\pi}{4}d\frac{L}{2}c\right\} \quad \cdots\cdots\cdots\cdots (6)$$

Consequently, the ultimate load can be calculated by solving equation (1) after substituting (3), (4) ,(5) and (6) into (1).

The calculation yields a satisfactory good approximation to the experimental ultimate loads, though some underestimation occurs.