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Behavior of Concrete-Filled Square Steel Columns

Comportement de piliers creux carrés remplis de béton

Verhalten von betongefüllten Stahlhohlstützen

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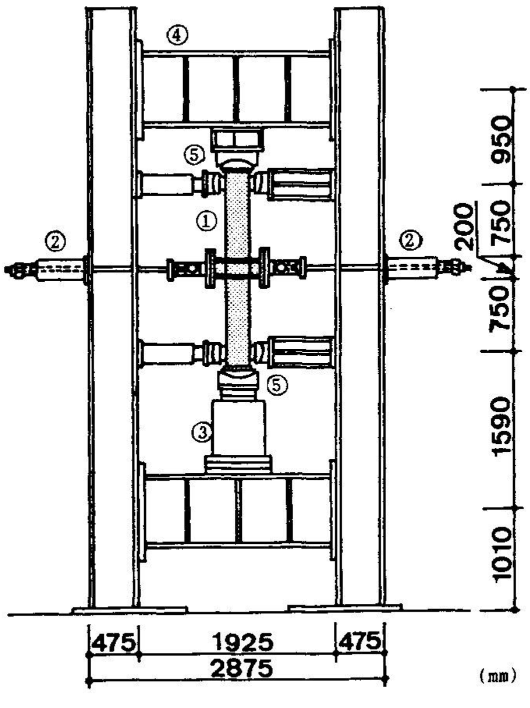
SUMMARY

The authors accomplished some experiments on the concrete filled square steel columns subjected to combined axial compression and bending moment. The confining effect between the steel tube and the core concrete, which increases the ultimate strength and ductility of the member, is widely admitted in case of the circular sections. The authors recognized the same effect even in the square sections, and propose a design formula which considers both the local buckling of the square tube and the increase of the concrete strength.

1. OUTLINE OF THE EXPERIMENT

The experimental set up is shown in Fig.1. Both ends of the specimens were simply supported and the alternative transverse force was added at the center of the span. Each specimen was also subjected to the constant axial force all through the experiment. The experimental parameters are tabulated in Table 1.

An example of the load-deflection curve is shown in Fig.2. The ultimate strength of the specimens were closely related to the local buckling of the face plate of the steel tube, and it usually occured prior to the strain hardning region of the steel. However, the ultimate strength of all specimens exceeded the value of the generalized superposed strength (see Table 1), and the specimens had considerable energy absorption capacity even in the range of the large width-to-thickness ratio of the tube and the large axial force.



① specimen
② hydraulic jack for the transverse force
③ hydraulic jack for the axial force
④ loading frame
⑤ pin-roller support

Fig.1 Experimental set up

2. ESTIMATION OF THE LOAD BEARING CAPACITY

The strength of the composite member can be estimated by the generalized superposed strength theory. The authors propose to

estimate the strength of the steel part and the concrete part as follows;
- steel part : To consider the effect of the local buckling, the effective width proposed by Foulkner[1] is used. The effective width is estimated by considering the post-buckling strength of the plate with clamped boundaries. It is given by

$$be = b\cdot(2.5/\beta - 1.56/\beta^2)\ ,\ \beta = b/t\sqrt{\sigma_Y/E} \qquad (1)$$

where be is the effective width, b and t are the width and thickness of the steel tube, σ_Y and E are the yield point and Young's modulus of the steel.
- concrete part : The confined effect is taken into account by using the following equation.

$${}_{cf}\sigma_B = {}_c\sigma_B\ \{1 + k(t/b)^2\sigma_Y/{}_c\sigma_B\} \qquad (2)$$

where ${}_{cf}\sigma_B$ is the compressive strength of confined concrete, ${}_c\sigma_B$ is that of plane concrete. The coefficient k is decided by compression experiments[2] as k=48.8. The generalized superposed strength of the specimens estimated by this method are tabulated in Table 1 (Calculation 2). Comparing with the normal generalized superposed strength (Calculation 1), it shows better agreement with the experimental values.

3. CONCLUSION

The confining effect can be considered in the concrete filled square steel tubes. By using the proposed estimation method, the ultimate strength of the section can be estimated in safety side.

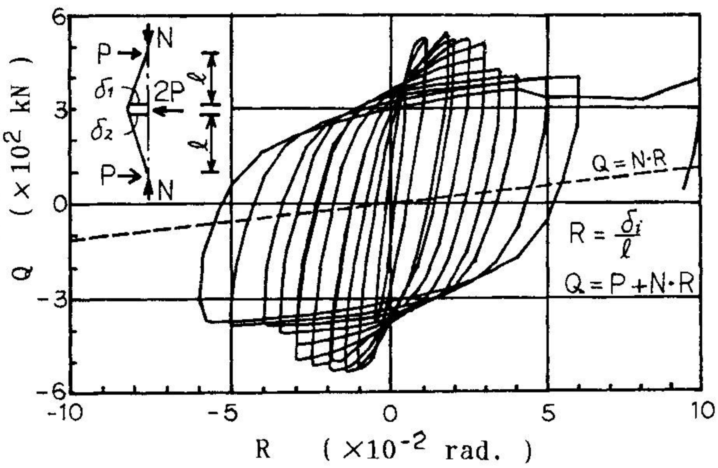


Fig.2 Load-deflection curve of R08M3

REFERENCES

1. D.Faulkner, A Review of Effective Plating for Use in the Analysis of Stiffened Plating in Bending and Compression.,Journal of Ship Research,Vol.19, No.1, Mar.1975.
2. Matsumura H. et al,Compressive Strength of Filled Concrete in Square Steel Pipe., Annual Meeting Report of AIJ, October, 1989.

Table 1 Experimental parameters and ultimate strength of the specimens

Name of Specimen	Experimental Parameters							Ultimate Strength by		
	Square Steel Tube				Filled Concrete		Ratio of the Axial Force *1			
	Width B (mm)	Thickness t (B/t) (mm)	Yield Point (N/mm²)	Tensile Strength (N/mm²)	Compressive Strength (N/mm²)	Young's Modulus (kN/mm²)		Experiment (kN·m)	Calculation 1 *2 (kN·m)	Calculation 2 *3 (kN·m)
R04L3		4.52(55)	357.9	500.1	30.2	23.83	0.3	228.5	198.4	189.7
R06L5		5.76(43)	371.7	543.3	30.2	23.83	0.5	243.2	210.0	228.5
R08L5		7.65(33)	358.9	540.3	30.2	23.83	0.5	275.6	244.8	299.0
R12L5		11.89(21)	316.8	509.0	30.2	23.83	0.5	432.5	298.9	399.7
R04M3		4.52(55)	357.9	500.1	38.0	34.81	0.3	287.3	212.6	203.7
R06M3		5.76(43)	371.7	543.3	38.0	33.83	0.3	347.2	255.0	260.7
R06M5		5.76(43)	371.7	543.3	38.0	34.81	0.5	349.1	226.6	243.4
R08M3		7.65(33)	358.9	540.3	37.0	33.24	0.3	400.1	297.5	325.7
R08M5		7.65(33)	358.9	540.3	38.0	33.83	0.5	413.8	257.5	309.9
R08M7	250	7.65(33)	358.9	540.3	37.0	33.24	0.7	365.8	178.6	260.9
R12M5		11.89(21)	316.8	509.0	38.0	34.81	0.5	560.0	315.5	411.8
R12M7		11.89(21)	316.8	509.0	38.0	34.81	0.7	451.1	215.5	367.0
R12M3H		11.61(22)	477.6	583.5	38.2	34.81	0.3	716.9	508.6	595.1
R12M5H		11.61(22)	477.6	583.5	38.2	34.81	0.5	634.5	427.3	578.3
R12M7H		11.61(22)	477.6	583.5	38.2	34.81	0.7	577.6	285.5	515.6
R06H5		5.76(43)	371.7	543.3	84.9	43.84	0.5	344.2	317.4	329.0
R08H5		7.65(33)	358.9	540.3	84.9	43.84	0.5	384.4	352.4	393.3
R12H5		11.89(21)	316.8	509.0	84.9	43.84	0.5	490.0	401.9	482.1
R12H7		11.89(21)	316.8	509.0	84.9	43.84	0.7	361.9	291.9	425.4

*1 N/NO where N is imposed axial force and NO is axial yield strength of the composite section
*2 generalized superposed strength by using σ_Y and ${}_c\sigma_B$ *3 generalized superposed strength by proposed method