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Strength of Column Embedded in Footing with New Reinforcement

Résistance d'une colonne encastrée dans une semelle de fondation

Tragwiderstand von Stahlhohlstützen in Stahlbetonfundamenten

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1. INTRODUCTION

The RHS column base embedded in the RC footing is commonly employed in the rigid column-footing connections and is capable of resisting the large bending moments. However, at the RHS exterior columns in the frame subjected to the lateral loads as shown in Fig.1, due to the loss in the bearing strength of concrete as a results of the failure of the cover concrete , it is more awkward that the strength of the embedded RHS exterior column-footing connection is greater than the full strength of the RHS column.
To avoid such premature concrete failure in the RHS exterior column-footing connection, an improved embedded type with the U-reinforcing bars arranged on the outside of the embedded RHS column is proposed. The advantages of such column base type are that the shear force and the bending moment can be smoothly transmitted from the RHS column to the foundation and the RC tie-beam through the U-reinforcing bars and the concrete.

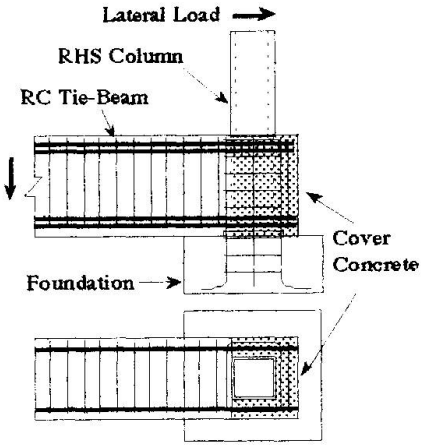


Fig.1 RHS Exterior Column-Footing Connection

2. TEST RESULTS

As shown in Fig.2, there are three possible collapse mechanisms. Based on the the assumption of a uniform distribution of the bearing stress over the full width of the steel section, the ultimate strength of the column-footing connection under the lateral loading is obtained.
The tests were conducted to evaluate the inelastic behavior, the lateral stiffness (K_{Rc}), the yield strength (Q_y) and the ultimate strength(Q_p). The geometrical configurations of ten specimens are shown in Fig.3 and are summarized in Table 1. The test variables are the arrangement of the reinforcement, the number of the U-reinforcing bars and the direction of the applied lateral load. Typical test results are shown in Figs.4 and 5.
The following conclusions can be drawn from the test results .

1) The lateral stiffness of the embedded column is estimated by the results of the analysis including the effect of the rotation resistance of the tie-beam.
2) The yield load and the collapse load of the improved embedded RHS exterior column base are well predicted by the present method through tests.
3) The U-reinforcing bars of the improved embedded RHS exterior column base is most effective in preventing the deterioration of resistance.
4) When the reinforcing bars of the tie-beam terminate at the exterior edge, a major crack at the inner side of the embedded column is restricted.

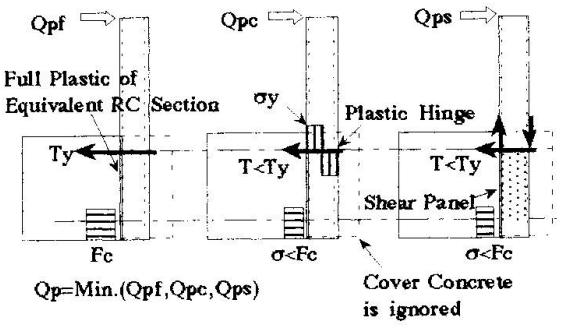


Fig.2 Collapse Mechanisms

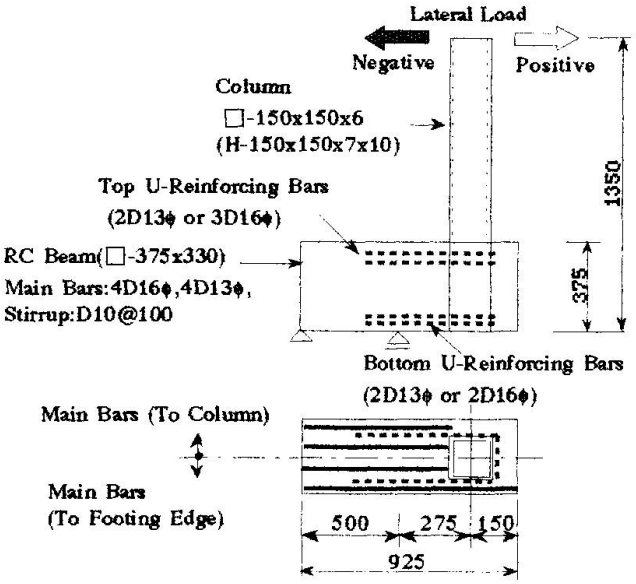
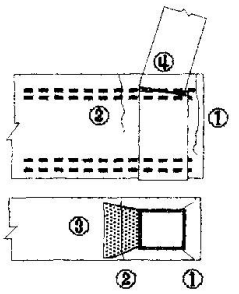


Fig.3 Test Specimens

Specimen	Column	U-Reinforcing Bars		Arrangement of Main Bars	Loading
		Upper	Lower		
No.1	□-150x150x6	2D13 φ	2D13φ	To Column	Positive
No.2	"	"	"	"	Negative
No.3	"	None	None	To Footing Edge	Positive
No.4	"	"	"	"	Negative
No.5	"	2D13 φ	2D13φ	To Footing Edge	Positive
No.6	"	"	"	"	Negative
No.7	"	3D16 φ	2D16φ	To Column	Positive
No.8	"	"	"	"	Negative
No.9	H-150x150x7x10	2D13 φ	2D13φ	To Footing Edge	Positive
No.10	"	"	"	To Column	Positive

Table 1 Summary of Test Specimens



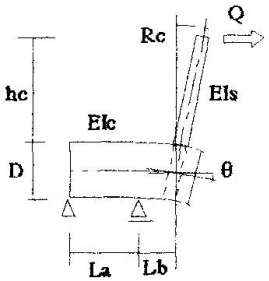
① Punching Shear (No.3,5)

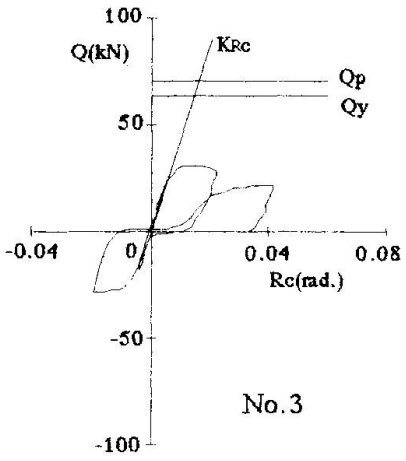
② Bending Cracking (No.1,9,10)

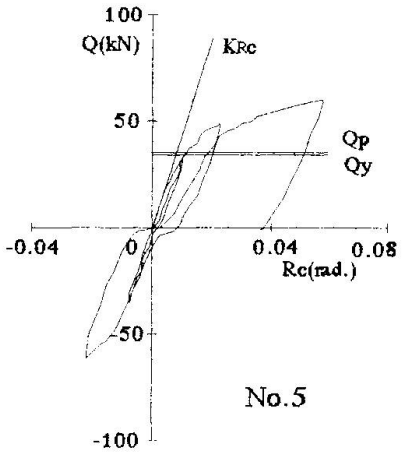
③ Concrete Crushing (No.2,4,6,8)

④ Full Plastification (No.7)

Fig.5 Crack Pattern and Failure Modes







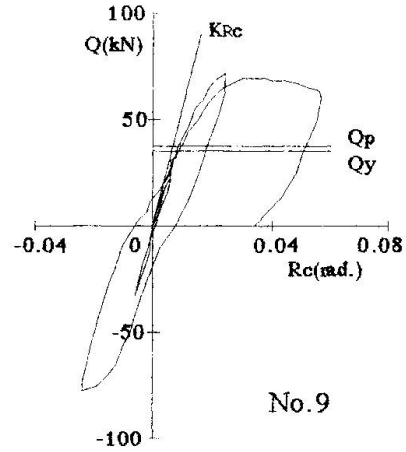


Fig.4 Typical Q-Rc Diagrams