Local Damage Control of Unconstrained Gusset Connections for Buckling Restrained Braces in RC Frames

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Summary

An unconstrained gusset connection for buckling restrained braces in reinforced concrete frame structures is proposed and tested. The results of the cyclic loading tests on the gusset connection subassemblies confirmed that the proposed damage control scheme is effective in controlling the locations of the beam hinges and thus preventing the BRBs from being dislocated from the entire structural system as a result of the beam end failure at extreme earthquake scenarios.

Keywords: buckling restrained brace; reinforced concrete frame; unconstrained gusset connection; damage control; plastic hinge relocation; post-tensioning; embedded stud

1. Introduction

The 'unconstrained gusset connection', which was originally proposed by Berman and Bruneau[1] for installing BRBs in steel constructions, is tried out for RC frames through experimental investigation. The gusset plate is 'unconstrained' because it is not constrained by the concrete column and is fastened only to the beam end. Figure 1 illustrates its use in diagonal braces as an example. It can be implemented in other bracing systems like V or inverted-V bracing as well.

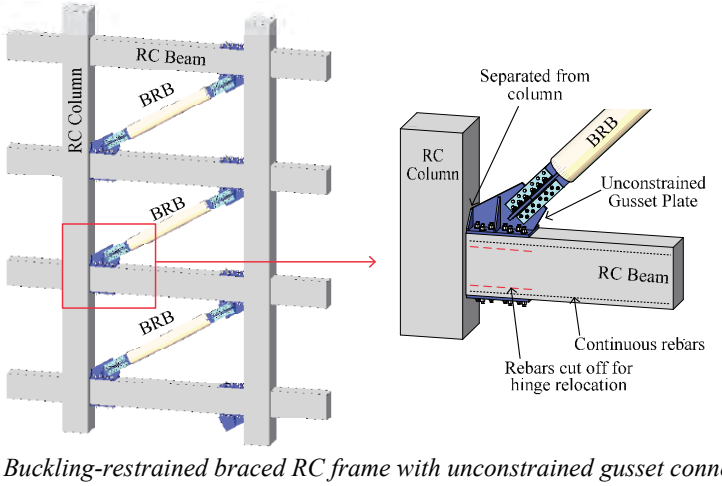

Fig. 1: Buckling-restrained braced RC frame with unconstrained gusset connection

A ‘damage control’ scheme is proposed for the local connection region in which the potential plastic hinge zone at the RC beam end is expected to be relocated outside the gusset connection region, that is, forward to the center of the span, similar in concept to the reduced beam sections (RBS) in steel moment-resisting frames. In this particular study, the beam longitudinal rebars are re-arranged to adjust the flexural strength of different segments of the beam in order to relocate potential plastic hinges.

2. Experimental Tests

The unconstrained gusset connection together with the damage control scheme is examined through subassemblage cyclic loading tests. The combinations of two types of connection details (i.e., post-tensioned type, or PT type, and embedded plate type, or EB type) and two sets of beam reinforcement lead to four specimens of braced beam. A bare beam was also included as the control specimen. Test Results and Discussions

Figure 2 summarizes the damage of the RC beams in terms of apparent cracks and strain distribution of the longitudinal rebars for two EB type specimens with and without local damage control.

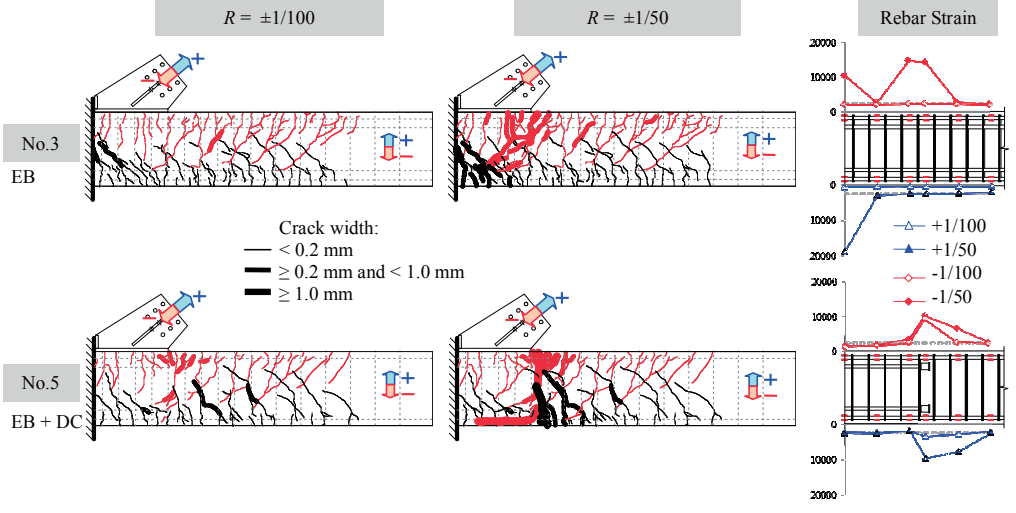

Fig. 2: Shear force and chord rotation of RC beam in EB type specimens with and without local damage control.

3. Summary

By the test results, the design for local damage control at the RC beam end was effective in moving the potential plastic hinge outside the connection region. An immediate benefit of doing so is to prevent the dislocation of the BRBs from the rest of the structure in case the beam fails in extreme earthquake scenarios.

References

[1] BERMAN J.W. and BRUNEAU M., “Cyclic testing of a buckling restrained braced frame with unconstrained gusset connections”, *Journal of Structural Engineering, ASCE*, Vol. 135, No. 12, 2009, pp. 1499-1510.