Paper Code. 4063

RETROFITTING DESIGN GUIDELINES USING STEEL PLATES AND SHEAR BOLTS

H. Marzouk and E. Rizk
Ryerson University, Toronto, Canada
hmarzouk@ryerson.ca

ABSTRACT

The current paper presents design guidelines for strengthening of concrete members using sandwich steel plates and steel shear bolts. In addition to our experimental investigation and other test results available in the literature, a theoretical investigation is conducted on different design aspects of sandwich steel plates and shear bolts. Design aspects of the strengthening techniques include minimum area of steel plates, design width of steel plates and extension of steel plates from the support face (loading zone). Design requirements for shear bolts include minimum and maximum spacing between shear bolts, minimum cross section area for shear bolts, distance between the support faces and the outer-most peripheral line of shear bolts.

The research work represents two design concepts for the design of the rehabilitated concrete connections. The first model is based on a truss model assumption. The second concept presents the design of sandwich steel plates based on the rational shear sandwich model. The recommended design deals with the required number of shear bolts according to minimum shear reinforcement requirements for concrete Plates, bolt spacing and thickness of the steel plate.

Key Words: Steel Strengthening, Shear bolt spacing, Plated Thickness strengthening; Concrete Plates and Cyclic moment on beam column connections.

1 INTRODUCTION

One of the most effective solutions to the seismic retrofitting is to design the size of steel plates and shear bolts required for strengthening. The use of steel bolts or shear studs (headed bars) are mechanically anchored studs with a plate or a head at each end that is capable of developing the yield strength of the studs. The stems of these studs intersect the shear cracks preventing their widening (Ghali and Megally 1999). In addition, the heads of the shear studs provide a good mechanical anchorage at both ends. The extensive investigations that were conducted by different researchers (Elgabry and Ghali 1990; Andrä 1981; Dilger and Ghali 1981; Mokhtar et al. 1985) on full-size concrete slabs verified that stud type reinforcement can substantially increase the strength and prevent brittle failure of plate slabs.

Marzouk and Jiang (1997) conducted an experimental investigation of HSC plates that are reinforced with five different types of shear reinforcement to prevent brittle shear failure. It was concluded that double bend, stud and T-headed shear reinforcements are the most efficient shear enhancement for concrete plates. The addition of shear reinforcement did eliminate the punching failure mode and it was transformed into flexural failure for the HSC plates that utilized the flexural reinforcement. In the meantime, both ductility and energy absorption of the plate slab was significantly increased by using shear reinforcement.