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LOAD DEFORMATION CHARACTERISTICS OF SANDWICH BEA IS WITH PARTIAL INTERACTION

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INTRODUCTION

Ever since the 1995 Hyogo-ken Nanbu earthquake, a great deal of interest has been directed towards the use of concrete-filled tubular steel members due to the numerous advantages that they posses such as high ductility and strength. However, to harness the full potential of filled steel members in line with current design emphasis on ductility, the replacement of cement concrete with more appropriate fill materials of higher ductility and durability e.g. polymer-based materials, is considered necessary as is supported by studies already conducted[1,2]. It is thought that one of the inherent attributes of polymers or polymer-based materials is their high adhesive strength and flexibility. Therefore, in any realistic model for the overall structural response, the interface condition between the components needs to be accounted for appropriately. In this study, the interface interaction between the fill material and the steel tube was simulated through flexural test on open sandwich beams.

EXPERIMENTATION

A total of six open sandwich beam specimens involving latex cement mortar-steel (LCM/S) combination and steel-steel (S/S) combination were tested in flexure under a central point load as illustrated in Fig. 1 and Table 1. Variables for each of the LCM/S and S/S combinations involved the nature of the interface bond (natural bond-ns or glued interface-gs using an epoxy adhesive) and the height ratio (${h_f}/{h_s}$) of the components forming the composite. Material properties i.e. Young's modulus (E), Poisson's ratio (ν), yield strength (σ_{sy}) and ultimate strength (σ_{sult}) are given in Table 2.

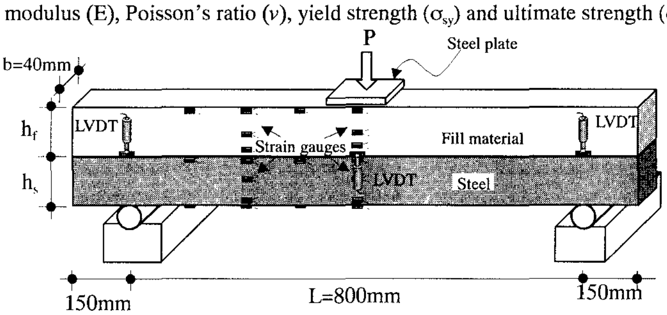

Figure 1. Open sandwich beam specimen under flexural loading

Table 1. Dimensions of test specimens

Specimen label	h_f (mm)	h_s (mm)	h_f/h_s (mm)
LCM/S-1ns	60	60	1
LCM/S-1gs	60	60	1
S/S-1ns	60	60	1
S/S-1gs	60	60	1
LCM/S-11ns	110	10	11
LCM/S-11gs	110	10	11

Nomenclature: e.g. LCM/S-1ns represents latex cement mortar-steel open sandwich beam of h_f/h_s=1 and of natural sandwich interface.

Table 2. Material properties

Material	LCM	Steel	
		h_s=10mm	h_s=60mm
E(KN/mm^2)	14.7	209	204
ν	0.200	0.276	0.303
σ_{sy}(KN/mm^2)	-	608	239
σ_{sult}(KN/mm^2)	16.8	661	430

RESULTS AND DISCUSSIONS

A glance at Fig.2 (a) promptly reveals the high adhesive property of epoxy resin when the glued steel specimen (S/S-1gs) is compared to the independent steel beam specimen (S/S-1ns). Using the formula τ_{max} =1.5F/(bh), where F is the debonding shear force, the debonding shear strength (τ_{max}) has been calculated to be 24.3 N/mm^2, equivalent to the design epoxy shear strength. When compared to the theoretical response of fully bonded interface, it may be concluded that even though epoxy considerably improves the interface bond, it does not provide a perfect one. Hence there is the need to determine the full extent of the effectiveness of epoxy resin.

In the case of latex cement mortar-steel (LCM/S) beams shown in Fig.2 (b), the difference between the glued interface and the natural interface seems to be negligible, and is more aligned towards the theoretical full interface interaction response than towards the theoretical no interface interaction response. This closeness may be attributed to the fact that fibre latex cement mortar is a polymer-based material, hence is likely to have a fairly high adhesive strength.

Keywords: Filled steel members, Flexural test, Interface bond, Open sandwich beams
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Figs. 3 and 4 give the strain distribution at the mid-span section of the tested beams, where compressive strains are taken as positive. The glued steel beam (S/S-1gs) in Fig. 3 (a), unlike beam S/S-1ns, shows a fairly homogenous behaviour, with the nearly linear strain distributions. This further highlights the high adhesive and/or shear strength of epoxy resin.

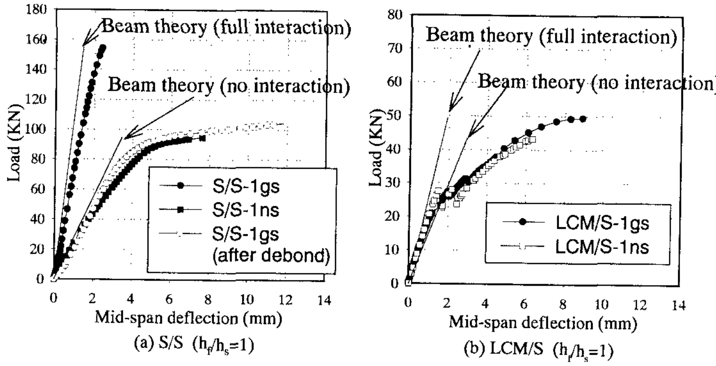

Figure 2. Load-deflection response of the tested beam specimens

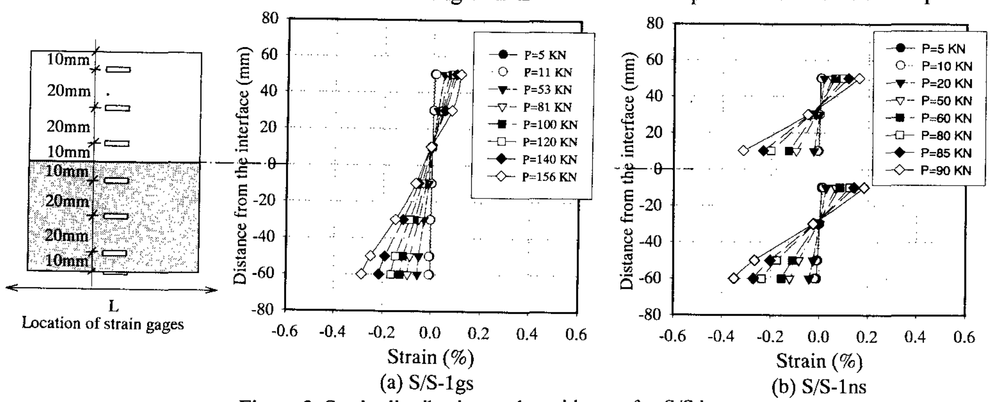

Figure 3. Strain distribution at the mid-span for S/S beams

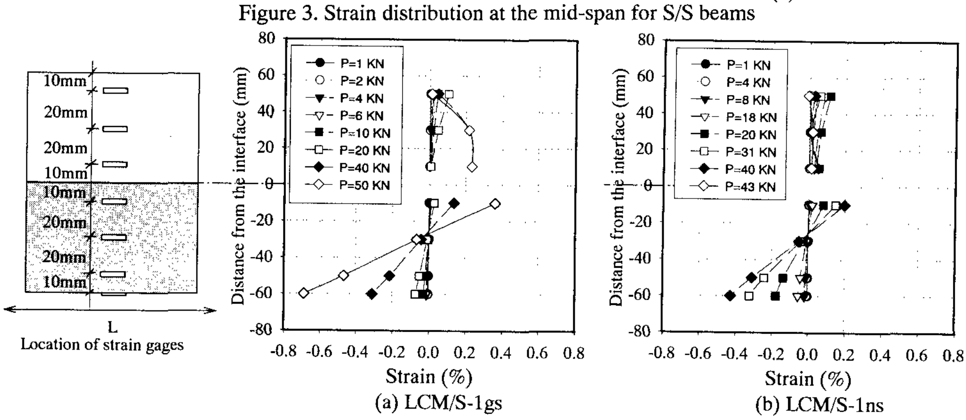

Figure 4. Strain distribution at the mid-span for LCM/S beams

CONCLUSION

The very high adhesive strength of epoxy resin has been demonstrated by means of steel-epoxy-steel interface, resulting in increased stiffness and strength of the sandwich beams. It is also noted that the natural bond in latex cement mortar-steel interface approximates that of the glued interface.

REFERENCES

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