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EXPERIMENTAL STUDY ON VIBRATION CHARACTERSTICS OF SANDWICH STEEL WELDED CONFIGURATIONS

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1. INTRODUCTION : The vibration characteristics of steel plates, bonded with adhesive, have been the subject of the interest since long. This study examines the vibration characteristics of sandwich steel beam like welded configurations. Such configurations appear quite frequently in steel bridges as weld connected members to the main girders. The study has two main objectives. Firstly, to examine the influence of weld induced constraints on well known core shear deformation mechanism[1], while the second objective is to testify the dependence of energy loss characteristics of sandwich steel on variation of frequency and amplitude of vibration.

2. DESCRIPTION OF TEST ELEMENTS

In all, seven types specimens were tested. Fig. 1 depicts these specimens. Table. 1 shows the dimensions of a typical specimen. All specimens are made of sandwich steel except specimen G2 which is made of homogenous steel and is similar in shape to sandwich steel specimen GS2. The purpose to include one homogenous steel element (G2) in the test scheme is to compare the energy loss and vibration characteristic response of the two type of steels.

3. TEST SCHEME

In the context of energy loss characteristics, the prime objective is to testify the energy loss dependence of sandwich steel on frequency and displacement amplitude. For this purpose the specimens were tested under fixed end conditions. A light, transverse impact was applied at the center of the specimen and the acceleration response of decaying wave was recorded. To include the effect of frequency dependence, specimens were tested under 0, 4 and 8 *tonf* axial tension. Fig. 2 shows the decay response of specimens GS2 and G2. As the damping response is quite rapid, the well known equation of system energy loss factor is applied in the following form

$$\eta_n = \frac{1}{n\pi}\, ln\,(\frac{A_n}{A_{n+1}}) \qquad (1)$$

where A_n and A_{n+1} are the response amplitudes at nth and $(n+1)th$ cycles, respectively.

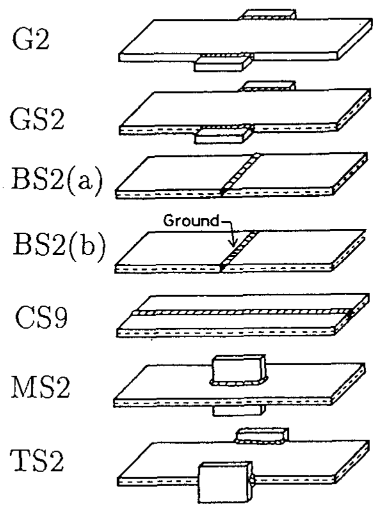


Fig.1 Test Specimens

Table 1: Specimen Dimensions

length (m)	0.60
width (m)	0.20
Face thickness (mm)	(5.0 + 5.0)
Core thickness (mm)	0.30
Axial load (ton)	0.0, 4.0, 8.0

From Fig. 3, it is evident that for sandwich steel (GS2), energy loss drops with the increase of frequency which is achieved by increasing the axial tension. On the other hand homogenous steel (G2) does not show any significant variation with the frequency variation as shown in Fig. 3.

The above mentioned test shows energy loss dependence on frequency variation. We notice that increase in the axial tension, under a constant transverse impact, reduces the amplitude response. In order to decouple the frequency variation effect the same specimens were subjected to free vibration test under cantilever support condition. Variation of amplitude was facilitated by changing the

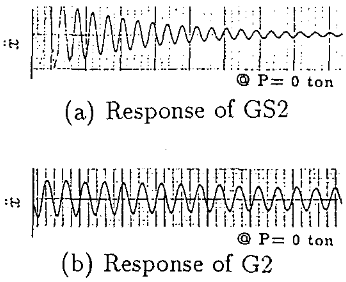


Fig.2 Response under Fixed End Condition

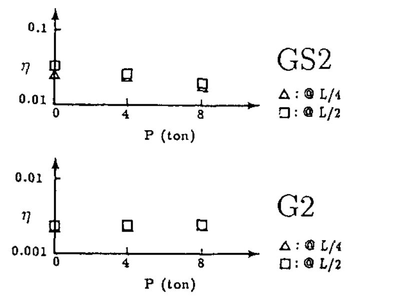


Fig.3 Load vs. Loss Factor

magnitude of the transverse excitation. Eq. 1 was used for the computations. Fig. 4 shows the displacement response at the free end for the specimens GS2 and G2. Fig. 5 clearly demonstrate that for sandwich steel (GS2), loss factor corresponding to high amplitude vibration, is higher. In case of specimen G2 the loss factor is almost insensitive to amplitude variation as shown in Fig. 5. Finally, Fig. 6 shows the comparison of frequency-energy loss relative response of various specimens.

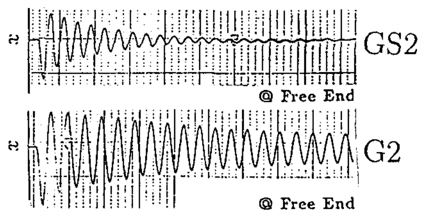


Fig.4 Cantilever Condition Response

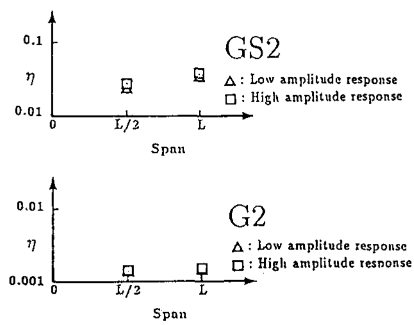
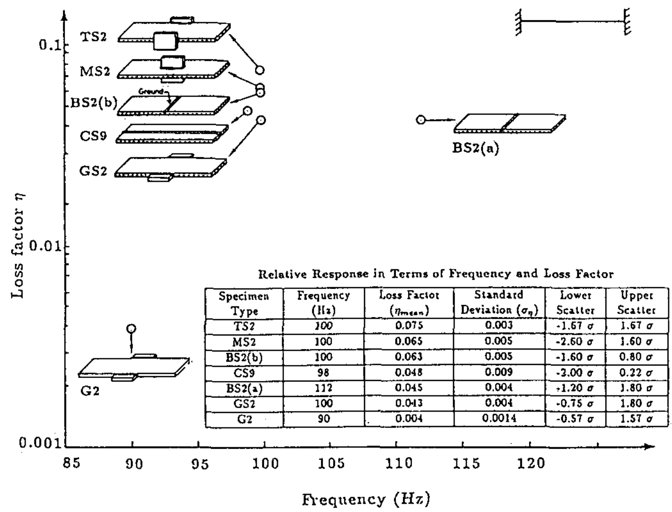


Fig.5 Amplitude Variation vs. η



Relative Response in Terms of Frequency and Loss Factor

Specimen Type	Frequency (Hz)	Loss Factor (η_{mean})	Standard Deviation (σ_η)	Lower Scatter	Upper Scatter
TS2	100	0.075	0.003	-1.67 σ	1.67 σ
MS2	100	0.065	0.005	-2.60 σ	1.60 σ
BS2(b)	100	0.063	0.005	-1.60 σ	0.80 σ
CS9	98	0.048	0.009	-3.00 σ	0.22 σ
BS2(a)	112	0.045	0.004	-1.20 σ	1.80 σ
GS2	100	0.043	0.004	-0.75 σ	1.80 σ
G2	90	0.004	0.0014	-0.57 σ	1.57 σ

Fig.6 Relative $f - \eta$ Response under Fixed End Condition

4. CONCLUSIONS: From the experiment we conclude that

1. The energy loss in sandwich steel is 20 to 30 times higher to that of homogenous steel.
2. In low frequency region, the energy loss is in proportion to amplitude of vibration.

REFERENCE

1. Y.P. Lu, B. E. Douglas 1974, Journal of Sound and Vibration 32(4),517-521