A FUNDAMENTAL STUDY ON DETECTION OF DEFECTS IN THE WEB GAP REGION OF STEEL BRIDGES BY THE PLATE WAVE ULTRASONIC TEST

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1. INTRODUCTION

Torsion induced fatigue $\operatorname{cracking}^{(1)}$ is one of the most serious problems encountered in steel bridges. Typically, visual inspection and magnetic particle testing have been applied to identify the presence of this type of crack. However, these techniques are time consuming and not always reliable. The goal of the study briefly described herein is to apply the plate wave ultrasonic testing technique to detect a fatigue crack in the web gap region of multiple steel girder bridges. The plate wave technique was selected in this application due to their long range propagation characteristics $^{2),3}$. In this study, experiments on a girder specimen were conducted to investigate the applicability of the plate wave technique. The influence of welded stiffeners and the detectability of drilled holes in the web gap were investigated.

2. OPTIMUM FREQUENCY FOR THE EXPERIMENT

Plate waves are dispersive. That is, the phase velocity of the wave is dependent upon the frequency. As the result, the selection of an appropriate frequency is important to accomplish this. **Fig. 1** which shows dispersion curves for steel plates was used. As can be seen, an S_0 mode of around 0-1.0 MHz mm is a suitable excitation zone because the velocity is the greatest and there are only two modes present. The frequency used in this study was selected to be in that zone. The thickness of web plate of steel bridges is usually less than 10mm. The frequency should be 1.0MHz mm/10mm=0.1MHz.

3. SPECIMEN AND SETUP

Fig. 2 shows the girder specimen tested in this study. The specimen was 4100mm in the length with an 8 mm thick web plate. Fig. 3 shows the general experimental setup. A pulse-receiver, an oscilloscope, and two transducers were used to generate the required wave forms. A laptop computer was used for data acquisition.



Table 1 Series of the experiment					
series	step	hole	stiffener		
1	1	no	no		
	0				

	2	one	no
2	1	no	no
	2	no	one
3	1	no	one
	2	one	one

4. EXPERIMENT AND RESULT

The experiments consisted of the series of tests when the stiffener and hole cofigurations were varied. These series are described in **Table 1**. Defects were made by a hand drill. The diameter of drill bit was 4 mm.

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Fig. 4 Wave forms of steps 1 and 2 of series 1

Fig. 4(a) and (b) show wave forms of steps 1 and 2 of series 1, respectively. The location of drill hole is shown in Fig. 4(b). In Fig. 4(a), an echo can be seen around 1.1 msec. This echo is the signal reflection at the far end of the girder specimen. In Fig. 4(b), another echo can be seen around 0.9 msec, while it could not be seen in Fig. 4(a). This echo likely represents the presence of the drilled hole defect.

Fig. 5(a) and (b) show the wave forms for steps 1 and 2 of series 2, respectively. The location of introduced welded stiffener plate is shown in Fig. 5(b). Comparing Fig. 5(a) with (b), an echo appeared in 0.8 msec in Fig. 5(b). This echo might be a reflection at the weld.

Fig. 6(a) and (b) show the wave forms for steps 1 and 2 of series 3, respectively. Considering wave velocity, an echo around 0.8 msec might be from the weld portion. Echo height of 0.8 msec in Fig. 6 (b) was a little higher than that of Fig. 6 (a).

5. SUMMARY

The applicability of the ultrasonic plate wave technique for the detection of defects in the web gap area of steel girder bridges was investigated. The results of the experiments are as follows:

(1) Defect echo could be observed clearly when there was no stiffener. (2) The presence of welded stiffeners might have some influence on the wave form. (3) It was very difficult to detect a hole when there was a stiffener present.

The authors would like to show the result of another series of experiments and propose an index to esti-



Fig. 6 Wave forms of steps 1 and 2 of series 3

mate the difference between two wave forms which can be used for automated monitoring. These would be addition items which were not described herein discussed during the formal presentation.

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