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The effect of connecting-rod I-beam-section specification on vibration-transmission and decay characteristics of diesel engines

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This study conducted experiments to investigate the piston-connecting-rod coupled vibration for several types of connecting-rods with different I-beam-section specifications. Furthermore, we analyzed the vibration-transmission and decay characteristics based on time-frequency-dependent combustion-noise-generation model for different connecting-rods and discussed the vibration characteristics on the engine outer surface. This model is expressed as follows:

$$dW_{en}(f,t)/dt = b(f)\eta_{vc}(f)W_{ci}(f,t) - c\{W_{en}(f,t) - \overline{W_{mn}}(f)\}$$

where, W_{en} is the engine noise power, b is the acoustic conversion coefficient, η_{vc} is the vibration-transmission efficiency, W_{ci} is the combustion impact power, c is the decay rate and $\overline{W_{mn}}$ is time averaged mechanical noise power.

We used four types of connecting-rods; OIS connecting-rod, which is initially installed on the engine, SIS connectiong-rod, whose I-beam section is shorter than OIS, TIS connectimg-rod, whose I-beam section is thicker than OIS, and NIS connecting-rod, which has no I-beam section. Figure 1 shows the spectrum of the vibration acceleration on the engine outer wall near main bearing for different connecting-rods. As can be seen in Fig.1, piston-connecting-rod coupled vibration frequencies with OIS, SIS, TIS and NIS connecting-rod are about 2.5, 2.8, 2.8 and 3.3 kHz, respectively. Therefore, the I-beam section specification affects piston-connecting-rod-coupled vibration frequency.

Since the vibration acceleration greatly depends on I-beam section specification, we investigated the vibration-transmission efficiency. Figure 2 shows the values proportional to vibration-transmission efficiencies for different connecting-rods. The vibration-transmission efficiency takes the maximum value near the piston-connecting-rod coupled vibration frequency. Furthermore, in the case with TIS and NIS, the vibration-transmission efficiency is significantly low as compared with the cases with OIS and TIS.

Figure 3 shows the spectrum of vibration acceleration of piston for different connecting-rods obtained by a 3D simulation. Figure 3 suggests that the decrease in the vibration acceleration of the piston by an increase of the thickness of the I-beam section is the cause of the decrease in the vibration-transmission efficiency to the outer surface.

Therefore, the thickness in I-beam section has a great effect on vibration-transmission efficiency and therefore vibration acceleration on the engine outer surface.

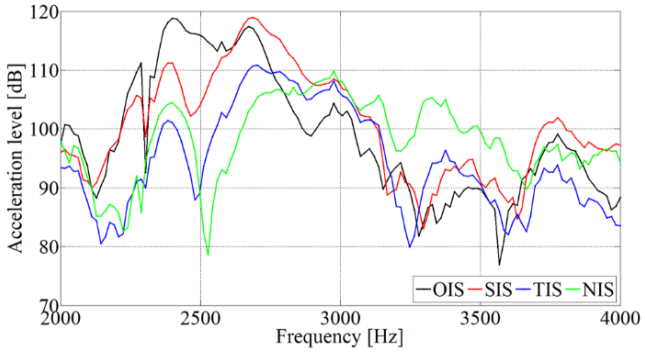

Fig.1 Spectrum of vibration acceleration of engine outer wall near main bearing for different connecting-rods

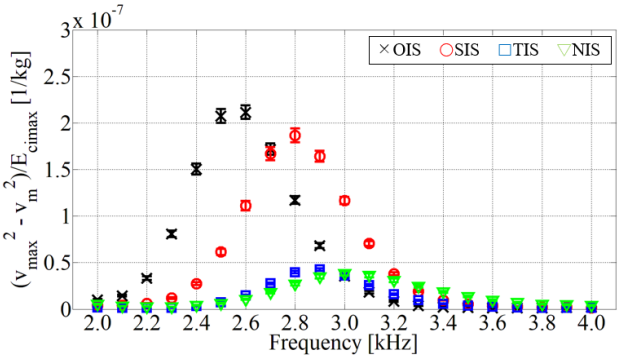

Fig. 2 Values proportional to vibration-transmission efficiencies for different connecting-rods

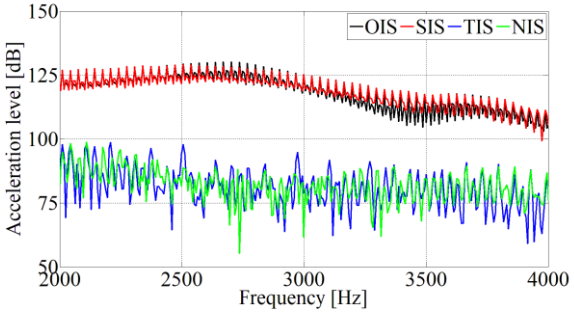

Fig. 3 Spectrum of vibration acceleration of piston for different connecting-rods (simulation)