One-Order Tuned Vibration Absorption of a Diesel-Generator

In four stroke engines, including diesel engines driving generators, each cylinder fires every other revolution. This causes the engine vibration to occur at ½ the engine RPM, called the ½ order vibration, and its higher order harmonics namely 1 order, 1½ order, 2 order. In the case of a diesel generator, in addition to the engine causing vibration at the ½ order and its harmonics, the generator imbalance causes vibration at 1 order.

In this project, abating the 1 order (25 Hz) transmitted vibration from three 170 KVA marine diesel generators, providing electricity in a motor yacht, to the hull of the boat was attempted. Considering the single frequency nature of the vibration problem, tuned absorbers were used in the project.

Four tuned vibration absorbers, targeting the 25 Hz vibration, were designed, fabricated, and installed on each of the three diesel generators, at their mounting feet. Figure 1 depicts one of these absorbers in action; the blurriness of the tuned absorber mass in the picture indicates the resonance of the absorber at the tuned frequency.

Figure 1 Tuned absorber installed on the front left mounting foot of the diesel-generator

Order in a machine is equivalent to the rpm of its rotating shaft. For example 2-order means twice the rotating speed.

Prior to the installation of the tuned absorbers, acceleration power spectra of the diesel generators at their mounting feet were measured. After installing and tuning the absorbers the power spectrum of acceleration at the same mounting locations were measured again. In addition, vibration at different locations on the boat (including the living quarters), before and after the treatment, were measured to evaluate how effectively the treatment absorbed the vibration of the diesel generators and prevented it from being transmitted to the hull of the motor yacht.

All measurements attested to the effectiveness of tuned absorbers in absorbing vibration at the target frequency of 25 Hz. For the sake of brevity, only the 'before' and 'after' measurements for one mounting foot of one of the generator sets is shown here. Figures 2 depicts these power spectrums prior to the installation of, 'before', and after the installation and tuning of, 'after', the tuned absorbers, at the 4 mounting feet of one of the diesel generators. Clear from Figures 2, the absorbers have effectively reduced the vibration power of the diesel generator, at the tuning frequency of 25 Hz. Although not presented here, the rest of the measurements indicated that vibration reduction at the tuned frequency of the absorbers (25 Hz) at the source did reduce the transmitted vibration to the hull at that frequency.

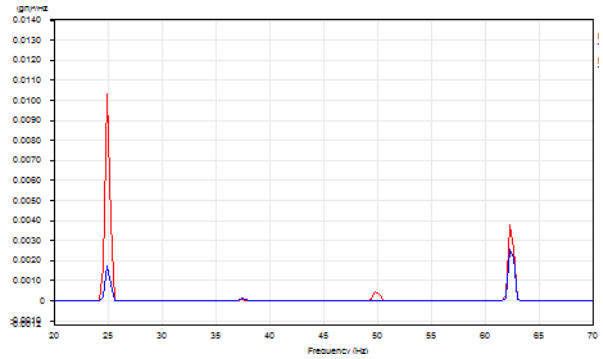

Figure 2 Acceleration power spectra of measured at one of the mounting feet, before (red) and after (blue) the tuned absorbers installation.

Appending 4 tuned absorbers weighing the total of 16 Kg effectively reduced the vibration of a 2-ton machine (engine weighs about 1100 Kg and generator weighs 950 Kg) at the tuned frequency. Although tuned vibration control devices are highly effective at their tuned frequency, they do not have much influence on other frequencies.