Discussion: Optimum geometrical properties of active isolation

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The discussers thank the authors for introducing a novel parameter, the trench efficiency index (TEI), in their paper (Jesmani *et al.*, 2011), to assess the trench efficiency in reducing the ground vibrations caused by machine foundations. The TEI can be used to take into account the changes of the amplitude of vibrations on both sides of a trench. This is important because the intensified vibrations in front of an open trench can be detrimental to the foundation.

The discussers have the following points, which need to be clarified by the authors. First, the discussers think that it is necessary to indicate clearly the frequency for which Figures 9–14 are plotted. This is because the Rayleigh wavelength is a function of the frequency of vibration according to the following equation

$$11. \quad \lambda_r = v_r / f$$

where λ_r , v_r and f are the Rayleigh wavelength, the velocity of the Rayleigh wave and the frequency of vibration, respectively.

Considering Figure 22 taken from Das (1993), when the Rayleigh wave propagates along the ground surface, the ratio of the vertical (W) and horizontal (U) displacement of a soil particle at a depth of $2\lambda_r$ to that of a soil particle on the ground surface is less than 0.05. Thus it can be concluded that increasing the trench depth beyond $2\lambda_r$ does not have a significant effect on the amplitude of vibration. In this context, Woods (1968) reported that active isolation using open trenches with a depth of at least $0.6\lambda_r$ results in A_{rr} of 0.25. Ahmad *et al.* (1996) showed that the foundation size is an important parameter that affects the trench efficiency. They showed that a trench with a depth of $1.5\lambda_r$ screens most of the stress waves caused by foundations with a radius of up to $2.5\lambda_r$.

In the paper under discussion, it is shown that increasing the trench

Figure 22. Variation of the amplitude of vibration of the horizontal and vertical components of Rayleigh waves with depth for Poisson ratio of 0.25 (Das, 1993) (from Das, *Principles of Soil Dynamics*, 1E. © 1993 Cengage Learning, a part of Cengage Learning, Inc., reproduced by permission, www.cengage.com/permissions)

depth up to 18 m still has a positive effect on the reduction of vibrations. This depth has been normalised with the Rayleigh wavelengths presented in Table 1 (which correspond to $f = 300$ Hz) and has resulted in $43.8\lambda_r$, $57.3\lambda_r$ and $69.8\lambda_r$ for the soil types m1,

m2 and m3 respectively. These values presented by the authors are well above $2\lambda_r$. In other words, the discussers argue that for Figures 9–14, and for $f = 300$ Hz, a trench depth of 18 m is much more than what is needed to reduce the vibrations.

On the other hand, if the results are obtained for $f = 10$ Hz, then the Rayleigh wavelength for the three types of soils are as follows

m1

$$\lambda_r = 132.2/10 = 13.2 \text{ m}$$

m2

$$\lambda_r = 94.2/10 = 9.4 \text{ m}$$

m3

$$\lambda_r = 77.5/10 = 7.5 \text{ m}$$

In this case, for soils m1, m2 and m3 the depth of 18 m corresponds to 1.4, 1.9 and 2.3 times the Rayleigh wavelength respectively, and using this range of trench depth (4.5–18 m) seems reasonable. Therefore, the authors are requested to stipulate clearly for which value of frequency their results are applicable.

Second, the discussers believe that trench efficiency is a function of the radius of the foundation. However, nowhere in the paper under discussion has the radius of the foundation been mentioned.

The last point of the discussers is that in Figure 2(c), a vertical constraint is applied to the left boundary of the model, while in reality there is no such constraint on the axis of symmetry of the problem.

The discussers also noticed the following inconsistencies and errors in the paper.

- (a) In the notation section of the paper, r_t is defined as ‘radial distance between trench and outer edge of barrier’. But in Section 5 of the paper (on A_{rr} and trench efficiency index), r_t is defined as ‘the radial distance between the foundation and the considered point’. The second definition seems to be correct.
- (b) In Section 4 of the paper (on model verification), the small letters should be used for the parameters depth (d) and distance (r), because the capital letters of these two parameters (D and R) are normalised by the Rayleigh wavelength according to Equation 10.

(c) Equation 8 should be corrected as

$$\overline{A}_{rr} = \frac{1}{n\lambda_r} \int_{r_b=0}^{r_b=n\lambda_r} A_{rr} \cdot dr_b$$

where $n\lambda_r$ is n times the Rayleigh wavelength and n is a natural number.

(d) The upper bond in Equation 9 ($r = 1$) does not seem reasonable. It can be corrected as $r = r_1$.

Authors' reply

The authors thank the discussers for showing interest in the published work, and going through it in detail. The authors would like to address the discussers' concerns thoroughly. It should first be mentioned that the main focus of this paper was on trench properties and the proposal of design recommendations for vibration isolation. A novel parameter (TEI) has thus been introduced. The effects of some other parameters have been investigated and published in the authors' previous papers (Jesmani *et al.*, 2008, 2009). In this research for the paper under discussion, analysis was undertaken for all of the mentioned frequencies to investigate the effect of applied loads on the isolation; the results of these analyses were presented in Section 6.5 of the original paper. All other analysis was performed for $f = 10$ Hz and, as the discussers suggested, to avoid any ambiguity, it should have been clearly mentioned that the rest of the analyses were undertaken for $f = 10$ Hz.

On the question of model boundary constraint the discussers are referred to Figure 2(b) in the original paper. As can be seen, there is no vertical constraint considered for edges. The upward arrows in Figure 2(c) show the constraint in the y direction, and not the z direction.

The definition of r_t is as mentioned in the text, where r_t is defined as the radial distance between the foundation and the point considered.

Small letters should have been used for the parameters depth (d) and distance (r) in Section 4. As the units have been presented immediately after the numerical values of depth and distance, it is clear that they are not normalised.

Equation 8 in the original paper was

$$\overline{A}_{rr} = 1/n\lambda_r \int_{r_b=0}^{n\lambda_r} A_{rr} \cdot dr_b$$

which is the correct form as per equation number 2 in Ahmad *et al.* (1996).

The discussers should note that the upper bound in Equation 9 is small letter *l* and not the numeral 1 (one).

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