5.4 EARTHQUAKE GROUND MOTION – SITE EFFECTS

Site effects play a very important role in characterizing seismic ground motions, because they may strongly amplify (or) de amplify seismic motions at the last moment just before reaching the surface of the ground or the basement of man-made Structures.

Some of the methods are,

1. Amplification Factor.
2. Non-linearity of soil response.
3. Empirical Modeling of Site Effects.
4. Topographic Effects.

1. Amplification Factor

When there are sharp changes in rock properties below the earth's surface, several things happen. First, there is a change in amplitude (usually an increase) as the upwardly propagating seismic wave traverses then, there is a change in impedance (usually a decrease).

Here the amplification factor is twice the inverse of the impedance contrast. The amplification factors in the frequency domain for two thicknesses, [t= 100m & t = 15m] of alluvium is shown in Fig .

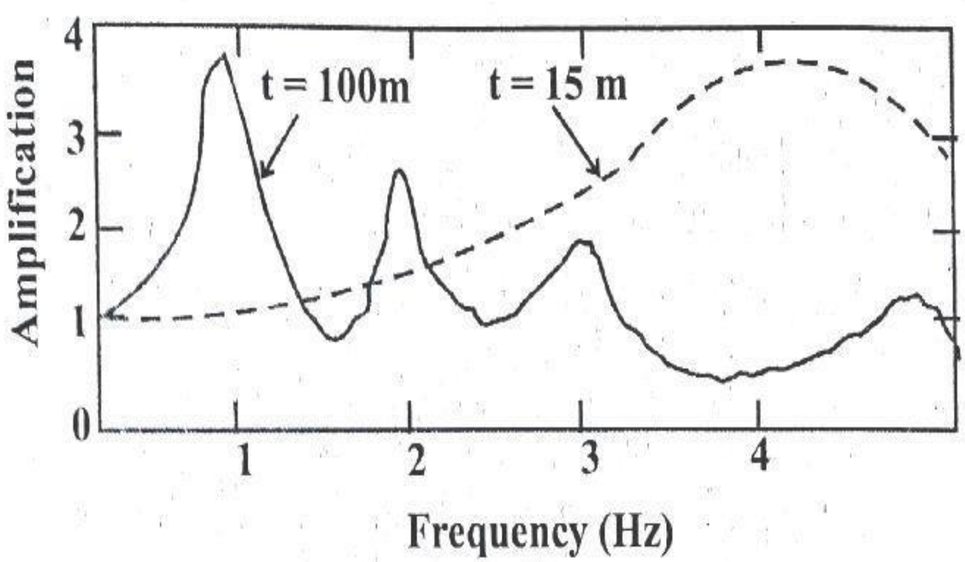

Fig:5.4.1-Graph amplification vs frequency

From the curves obtained, we can find that the amplication factor is higher at lower frequency & vice versa. Further, we can notice that the amplification factor is higher at lower thickness and vice versa.

2. Non-linearity of soil response

Nonlinearity is the phenomenon which allows for changes in soil properties and therefore changes in soil response as the level of ground motion increases. Nonlinearity of soil response is also called strain dependence, because the strain in the soil during an earthquake increases with the level of stress or ground motion.

Therefore, the soil nonlinearity is characterized by the following factors

(i) Reduction of shear rigidity.

(ii) (ii) Reduction of shear wave velocity.

(iii) (iii) Increase of damping factor.

3. Empirical Modeling of Site Effects

If we obtain site effects directly from observed data; such an approach is called an empirical modeling approach.In the empirical modeling of site effects, we must observe strong or weak ground motions due to one or more earthquakes and analyze data to extract site effects.

4. Topographic Effects

There are so many different observations on the strength of the topographic effect. The observations are

1. Even a rock site has strong site effects due to the upper surface structure.
2. Further it may be difficult to distinguish the effects of the subsurface structure and those of the topography from observed site effects, unless we know the subsurface velocity structure of the site in detail.
3. Surface waves, or body waves, is likely to happen but more than two arrivals with the same phase rarely meet at the same location.
4. Strong topography can be found only in the mountain area, where amplification itself is basically low compared to the bottom in surface.

Conclusions

1. The essential aspects of the site-effect studies are reviewed by focusing mainly on the physical modeling scheme to reproduce wave propagation phenomena in the shallower part of the Earth.
2. Physical properties of the actual complex structures of the Earth can be obtained by various geological, geophysical, and geo technical methods, which can be used in the physical modeling scheme.
3. Once a physical model of the whole area of interest is calibrated to actual observation, then such a model of the ground will be a common property of people, on which we can depend forever.
4. To conclude, physical modeling of the ground is now a realistic and effective approach for practical evaluation/ prediction of site effects.
5. The advantage of the physical modeling approach is that it can predict site amplification for any hypothesized sources that have not yet happened but will happen in the near future.
6. Thus, we may need to develop a way to translate site effects evaluated by a physical modeling approach into simple but with effective engineering representations for better seismic design of structures.