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ACCELERATION DIRECTIVITY, STRONG GROUND MOTION AND DAMAGE DURING THE KOBE EARTHQUAKE OF JAN. 17, 1995

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Kobe earthquake occurred on 17 Jan 1995 at 05.46 local time, measured 7.2 on the Richter scale magnitude. Seismic moment was 2.5×10^{26} dyne.cm^{-1} and the focal mechanism corresponded to strike slip faulting with significant reverse component (rake=165^{o}).

The aftershock distribution marks the trace of the ENE-WSE trending fault boundary between “Rokko Mt” horst and “Osaka basin” graben. The southwestern prolongation of this fault zone corresponds to Nojima fault on Awaji island. The overall length of the aftershock area was about 60 km.

There was marked directivity in acceleration values. That is, the highest horizontal acceleration values were measured along the fault while towards the ENE direction acceleration values were quite amplified. This has been found that it is due to the Doppler-Fiseau effect, as the main shock actually consisted of three east-north-eastward propagating sub-events, that all took place within 11.5 seconds.

The attenuation of the maximum acceleration remained rather constant within 10 km from the fault zone and decreased rapidly for longer distances. This was mainly due to the fact that the energy release source was about 14 km deep and the attenuation with distance of wave travel was approximately the same for the region. The maximum recorded horizontal acceleration values ranged from 200-800 gal, depending on site conditions, that is: acceleration values for soil ground surface had a two- to threefold amplification (679-818 gal); for artificial fill, however, the acceleration values were equivalent to that of rock (about 300 gal). As regards maximum velocity and displacement, artificial fill showed high response (max vel=81 kine, max displ=34 cm) because of the occurrence of liquefaction.

Building damage in the meizoseismal area depends on two major factors: distance from the fault zone and foundation conditions. Extensive survey on wooden houses in downtown Kobe, Ashiya and Nishinomiya showed that the highest absolute damage values were observed on soft soil and artificial fill. The same could be stated for other building types. However, for given foundation conditions there is a strict dependence of the damage ratio on the distance from the fault zone. Peak values (for any type of ground) are observed at about 4-5 km from the fault zone, a fact attributed mainly to interaction between hard rock basement and soft basin sediments, and the interference of the horizontally travelling waves with the vertically travelling ones, giving rise to the so-called “bump effect”. Damage becomes very limited after a distance of 10 km, regardless foundation conditions.

The following conclusions can be drawn:

- Strong ground motion remained constant from 5 to 10 km from the fault, given same ground conditions. Damage distribution varied for various ground conditions and decreases for a distance more than 10 km from the fault.
- Vertical acceleration values were higher than horizontal ones, especially in artificial fill, where horizontal motion was deamplified due to nonlinear effects. Vertical component of motion was amplified due to strong velocity contrast in the upper layer and small damping characteristics for longitudinal waves under strong motion.
- Strong earthquake motion values showed that attenuation with distance from the fault zone was found to have two times larger acceleration values in the rupture propagation direction. This can be attributed to Doppler-Fiseau effect.
- Highest damage occured at a distance of 2-4 km from the fault zone, a fact attributed to the critical depth of basin fill sediments that gave rise to the interference of horizontally and vertically travelling waves.