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Washington, D. C. 20555

Dear Leon:

I am very much concerned about the adequacy of the Delta earthquake model now. Their refined model with randomly slipping 50 meter block implies a crack of a radius of 25 meter slipping by 1 meter. This would imply a stress drop on the order of 10 kilobars.

The need for such refinement is described on page 4-3. I quote:

> "The effects of focusing are too severe at high frequencies. For example, the computed horizontal accelerations at station 6 were both in excess of 1 g. Similarly, the earthquake model predicted in excess of 1.2 g at station 2 for the 1966 Parkfield earthquake. However, as evidenced in all the important earthquakes studied with the computer model to date, focusing from actual earthquake rupture affects horizontal ground motions predominantly at frequencies below 3 Hz. ...
>
> The computed horizontal ground motions at high frequencies are deficit with respect to the data for distances greater than about 10 km from the fault trace. This is, to some extent, a result of excessive focusing of seismic energy along the path of rupture. ..."

As far as the case of station 2 of Parkfield earthquake is concerned, I can confidently say that there is a better explanation.

I believe that the large impulse observed during the Parkfield earthquake is a near-field effect due to the passage of rupture front near station # 2. The reason is simple. I modelled it with various fault lengths, and the result was not affected by the fault motion more than a few kilometers away. Detailed discussions were given in my paper published in JGR 73 (1968), 5359-5376, and reproduced in Aki-Richards

(p. 829). As discussed in Aki-Richards (p. 827), the near-field effect decays with distance as r^{-4}, and therefore the mesh size for point-source superposition must be less than the minimum distance to the fault divided by 4. In the case of #2, the mesh size must be less than 20 meters. In the case of stations 6 and 7 for Imperial valley, it must be less than 250 meters. The Delta's 1 km mesh is not adequate for the accurate calculation of near-field effect. The accuracy should be poorer for longer period, because the near-field is richer in low frequency. (In this respect, I was very much puzzled by the results of Delta's earlier mesh size study for close-in case.)

Anyway, the near-field effect of passing rupture front can reproduce the "focusing" observed only for relatively low frequencies, because the near-field term attenuates exponentially with frequency (Aki-Richards, p. 835). For example, the calculation by Richards (Aki-Richards, p. 872) for elliptic crack shows the S-wave with a sharp step-like function and a relatively smooth but large motion associated with passage of crack-tip.

So, I suggest that the observed large motion near the fault is not due to the focusing effect but due to the near-field effect of crack-tip passage, and I suspect that the near-field effect may not be adequately represented in Delta's calculation.

If the near-field effect is correctly represented, there may be no need for high rupture velocity assumed in Delta's model. In fact, the rupture velocity of 2.2 km/sec (about 60% of basement shear vel.) can adequately explain the station #2 record (Bouchon, JGR, 1979). This velocity is consistent with observed nulls in spectra (Filson-McEvilly, 1967) and agrees with the direct measurement by Eaton using the chronograph at Gold Hill.

Since the focusing effect is proportional to $(\beta/v - \cos\theta)^{-1}$ (Aki-Richards, p. 846), the Delta's 90% shear velocity will give $\frac{(1.6 - 1)}{(1.1 - 1)} = 6$ times larger focusing effect than the 2.2 km/sec velocity. Since this focusing occurs for all frequencies, it results in excessive focussing for high frequency waves, requiring smoothing by introducing the refinement of model.

I am convinced that the near-field effect is more important than the focusing effect at Station #2 for the Parkfield earthquake, but I am not absolutely sure about # 6 and # 7 of Imperial Valley and # 6 of Coyote Lake. Currently, Dr. Bouchon is working on these earthquakes, and I hope that the problem may be resolved in the near future.

Sincerely yours,

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