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COMMENTS ON "NEW ATTENUATION RELATIONS FOR PEAK AND EXPECTED ACCELERATIONS OF STRONG GROUND MOTION," BY B. A. BOLT AND N. A. ABRAHAMSON

By W. B. Joyner and D. M. Boore

Bolt and Abrahamson (1982) imply that we neglected to provide sufficient flexibility in the form of the ground-motion attenuation relationship used in our recent study (Joyner and Boore, 1981). We disagree with this implication, and we want to be sure that there is no misunderstanding concerning our views in the matter. We deliberately constrained the geometric spreading coefficient to 1 (i.e., $1/R$ spreading) in our relationship because we did not believe that the data set permitted physically meaningful, simultaneous determination of a spreading coefficient *and* a coefficient of anelastic attenuation. [We believe that the relationship used by Bolt and Abrahamson has too many free parameters; this is evidenced by the physically implausible values they obtain for the geometric spreading coefficient, which ranges from −0.2 to +0.38 (corresponding to values of 0.1 to −0.19 for the parameter c in their equation 9).] They contend that because our functional form is insufficiently flexible, our near-source estimates of motion are largely determined by the data at larger distances. In an attempt to prove the contention, they repeat our analysis removing the data points from stations at distances less than 8 km and report parameter values very close to what we obtained for the whole data set. This, however, only proves that the truncated data set and the whole data set are compatible with the same set of parameters, nothing more. The best way to determine how well our curves fit the data at short distance is to examine the plots of residuals given in our paper. A detailed discussion of our method and results is given in that and a subsequent paper (Boore and Joyner, 1982). Contrary to their contention, our near-source estimates for magnitudes in the 5.0 to 7.0 range are not largely determined by the data at larger distances. Indeed, for magnitudes 5.5 and 6.5, our near-source (0.1 km) estimates agree within 18 and 2 per cent, respectively, with the estimates they obtained for the magnitude ranges 5.0 to 5.9 and 6.0 to 6.9 using their more flexible functional form. Above magnitude 7.0, our near-source estimates are determined by the data points at large distance *and* a functional relationship with distance that is controlled by parameters determined by fitting the whole data set. Thus, a combination of the distant data points at magnitudes greater than 7.0 with the near-source data points at magnitudes less than 7.0 determines our near-source estimates for magnitudes greater than 7.0. If one does not wish to use such a strategy, one must forego near-source estimates for large magnitudes. As Bolt and Abrahamson demonstrate, an attempt to make such estimates using only data for magnitudes greater than 7.0 leads to the unlikely result that the estimate for magnitude 7.0 to 7.7 is less than that for 5.0 to 6.0.

A second point requiring comment is their statement (p. 2314) that "available acceleration data do not imply a systematic increase in peak acceleration with magnitude in the near-source region . . ." We believe that this statement is contradicted by their own results, which they appear to have misinterpreted by virture of confusing the standard deviation of an individual observation with the standard error of the mean. They obtain intercepts at $x = 0.1$ km of 0.34 g for the magnitude range 5.0 to 5.9 and 0.52 g for the range 6.0 to 6.9. They then take the data points for $x < 10$ km in the two magnitude ranges, compute standard deviations of 0.08 and 0.19 g, respectively, and conclude that the difference in intercept values is not significant. We repeated the calculations, obtaining similar values, 0.085 and 0.19 g, but these are standard deviations of an *individual* observation. The corresponding standard errors of the *mean* are 0.02 and 0.04 g, indicating that the difference in intercept between the two magnitude ranges is significant. Simple visual inspection of the data points for $x < 10$ km plotted on their Figure 2 leads to the same conclusion.

A final point concerns using the arithmetic value of acceleration in the regression analysis, as Bolt and Abrahamson have done, instead of using the logarithm of acceleration, as we and most other workers in this field have done. We believe the use of the logarithm of acceleration is clearly preferable because the residuals fit a log–normal distribution with a variance that is approximately independent of distance (Esteva, 1970; Donovan, 1973; Donovan and Bornstein, 1978; Campbell, 1981; and for spectral ordinates McGuire, 1978). Bolt and Abrahamson argue for their choice by pointing out that it gives more weight to the near-source data relative to the distant data. It is true that their curves are a poor fit to the distant data points (their Figure 2), but it is unclear to us that they have achieved any compensating advantage. As previously noted, their near-source predictions for the magnitude ranges 5.0 to 5.9 and 6.0 to 6.9 are very close to ours. They would be hard-pressed to prove that their predictions fit the near-source data any better than ours for magnitudes less than 7.0, and, as previously noted, there are essentially no near-source points in the data set for magnitudes greater than 7.0. As for the distant data, we judge from their Figure 2 that all of the more than a dozen data points at distances greater than 70 km in the magnitude range 6.0 to 6.9 lie above their curve by up to 0.04 g. We realize that 0.04 g does not have much engineering significance, but it represents an order of magnitude difference between observed and predicted.

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