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An Approach for the Estimation of Design Basis Near-Fault Earthquake Ground Motions

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In many parts of the world logistic, strategic, economical and financial circumstances and considerations make it impossible to avoid areas with a high seismic hazard and even near-fault regions for urban and industrial development. A recent portrayal of this was the 1999 Kocaeli earthquake, which hit a region in Turkey housing about 40% percent of the industrial and economical potential of the country. Therefore, within the context of earthquake engineering, the design of specific structures, such as bridges, industrial buildings etc. in near-regions in particular, become very important.

Two examples will be provided in this paper to illustrate a hybrid approach that can be taken to provide design basis earthquake ground motions for near-fault conditions. The procedure relies on the combination of the deterministically obtained low-frequency (DC-1Hz) ground motion with the stochastically simulated high frequency components.

The first example was produced as part of a 1997 study of the seismic hazard assessment of a port facility in Izmit Bay area. The proposed design basis ground motions are compared with the near-field ground motion data obtained during the 1999 Kocaeli earthquake, which struck the very same area, where this study had been conducted.

The second example is from a study carried out to assess the performance of the Bolu Viaduct in the 1999 Duzce earthquake. The viaduct was nearly complete, when the Duzce earthquake took place, damaging its seismic isolation system completely and bringing the viaduct near collapse. Analysis of the viaduct using the near-fault ground motions, simulated for fault rupture and site conditions consistent with the Duzce earthquake, yielded high displacement demands imposed by the earthquake and implied that even if the design of the isolation systems were in compliance with the AASHTO requirements, it would be very difficult for the viaduct to avoid damage.

Finally the significance of the assessment of near-fault ground motions is shown using the carried out for the envisaged Izmit Bay crossing. Estimated near-fault absolute and differential displacements and velocities for equi-spaced points on the crossing alignment are presented. Measure displacements and velocities in the same area during the Kocaeli earthquake are compared.