



## **OBSERVED DAMAGE AT BURIED PIPELINES DURING THE 1999 KOCAELI (IZMIT) -TURKEY EARTHQUAKE**

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There is a need for improved engineering tools for the prediction of earthquake damage to buried pipelines located especially at, along or in the vicinity of the fault rupture. In this paper, an investigation of the earthquake response of the segmented sewage pipeline system to the south of Izmit Bay during the 1999 Kocaeli (Izmit)-Turkey is presented. The ruptured fault of the 1999 Kocaeli earthquake ran parallel to the south coast of the Izmit Bay where the main collector line of the sewage system was located. Both the pipe- and the fault lines were lying in the east-west direction whereas the secondary collectors were oriented in the fault normal direction. The proximity of the pipeline to the ruptured fault segments varied between 0 and 1000 meters for a distance of nearly 20 km's, from Izmit (east) to De#287;irmendere (west). In this region the pipeline damage was of more continuous type and was expressed in terms of "damage ratio" per line or length. The pipeline exhibited complex behaviour due to combined effects of surface faulting, liquefaction induced lateral spreading and consolidation of the soil. Between De#287;irmendere and Alt#305;nova (further west) the fault distance gradually increased up-to 5 km's and thus the pipeline damage could be expressed in terms of "number of pipeline failures per km". Observed damage at manhole locations were compiled and overlain on to GIS based PGA, PGV, and soil classification maps. The validity of code-based vulnerability relations were investigated. In cases where sufficient correlation was not obtained, the study was extended to see the effects of lateral spreading and soil layering on damage distribution. Whenever available, vertical damage pattern and soil stratifications were presented. Boring data, measurements of documented local lateral spreading cases and change in pipeline elevations were overlain at these particular locations. Comparisons

were made between observed settlements, and predicted and measured lateral ground movements.