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Filter diaphragms are used in earth dams to intercept zones of low lateral stresses and possible cracking which can occur along embedded conduits due to differential settlement. Natural Resources Conservation Service (NRCS) first published criteria for sizing filter diaphragms in 1985, which express the diaphragm size as a function of the outside diameter (O.D.) of the conduit. The NRCS criteria have since become a widely used standard for designing filter diaphragms for small and medium-sized dams.

This paper presents the results of a finite element analysis to check the validity of NRCS filter diaphragm design criteria for both new construction and rehabilitation scenarios. The impetus for this study is the fact that the original NRCS criteria for sizing filter diaphragms were based largely on judgmental estimates by its senior geotechnical engineers at the time, rather than on more rigorous analyses. Furthermore, these criteria were originally formulated for new construction, while most current NRCS activity with dams centers on rehabilitation of existing dams.

In this study, finite element analyses are used to show the extent of the conduit's influence on the stress patterns within the embankment fill. The analyses examine the effects of the following factors on required filter diaphragm size: 1) rigid vs. flexible conduit; 2) size of conduit; 3) shape of conduit (round, rectangular, and "horseshoe"); 4) embankment height; 5) depth of compressible foundation; 6) cradle effects; and 7) trench effects (including "cut-and-cover" conduit replacement).

The finite element study generally confirms the safety of the NRCS criteria for typical round conduits for both new construction and rehabilitation scenarios, but it suggests the advisability of additional, site-specific analyses for conduits of larger size or irregular shape and for conduits founded on bedrock. The study also suggests several other minor modifications to current criteria, including: 1) using the vertical dimension of the conduit/cradle assembly instead of the outside diameter to size the diaphragm; and 2) setting minimum dimensions for diaphragms on small conduits (O.D. less than about 30 inches).