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Numerical Investigation of the Imposed Earth Pressures on Three-Sided Reinforced Concrete Culverts Supported on Non-Yielding Foundation Soil

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Extended Abstract

This paper numerically investigates the earth pressures applied on the sidewalls and top slabs of three reinforced concrete (RC) three-sided culvert (TSC) with spans between 7.3 and 13.6 m. Validated two-dimensional (2D) finite element models of the TSCs were employed to simulate different construction scenarios representing the Canadian Highway Bridge Design Code (CHBDC) (CSA 2019) standard installations, i.e., B1 and B2 standard installations, the case of dumped soil, and other backfill conditions. Three backfill soil types with different compaction levels were considered in the numerical analysis. The subsurface soil condition was assumed to be competent rock (non-yielding foundation soil) in all the considered scenarios. The vertical arching factor (VAF), used to estimate the vertical earth pressure on the top slab, and horizontal arching factor (HAF), used to estimate the lateral earth pressure on the sidewall, were determined at different backfill heights. The results indicated that the VAF increased as the compaction level of the sidefill material decreased. On the other hand, the HAF increased as the compaction level of the sidefill material increased. The estimated results were compared with the values stipulated in the CHBDC (CSA 2019), which are adopted for RC box culverts and are currently used for RC TSCs as well. The results indicated that the VAF code values consistently exceeded the estimated values from the numerical models. However, the estimated HAFs in some scenarios exceeded the maximum values specified in the code, which reflects the need to increase the maximum HAFs stipulated in the CHBDC (CSA 2019) for the case of TSCs supported on non-yielding foundation soil.

Keywords: three-sided culverts, finite element analysis, soil-culvert interaction, earth pressures.