ABSTRACT

Traffic flow generates vibrations or repetitive loading on the underlying subgrade. These repeated vibrations cause a reduction in soil bearing capacity, resulting in a shorter pavement service life than the design life. This study aims to analyze the dynamic behavior of subgrade soils beneath rigid pavements under repeated vehicle loading using field experimental measurements with accelerometers and laboratory testing using a dynamic triaxial apparatus. The results indicate that vehicle speed and weight significantly influence the vibration amplitude and frequency transmitted to the subgrade. The mathematical model describing the relationship between vibration amplitude (A), vehicle speed (V), and vehicle weight (W) is: $\boldsymbol{A=6{,}226x10^{-5}.V^{0{,}551}.W^{0{,}718}}$. *The mathematical model describing the relationship between vibration frequency (f), vehicle speed (V), and vehicle weight (W) is: :* $\boldsymbol{f=0{,}00644.V^{-0{,}378}.W^{0{,}923}}$. *The study also demonstrates that increasing vibration frequency and amplitude leads to an increase in the excess pore water pressure ratio, which can be predicted using mathematical models. The relationship between the excess pore water pressure ratio (Ru), vibration amplitude (A), and sand content percentage (P) is expressed as:* $\boldsymbol{Ru=0{,}1271+5{,}6444.A+0{,}00193.P-14{,}4860A^2+0{,}01271.A.P-0{,}00000229.P^2}$. *Meanwhile, the relationship between the excess pore water pressure ratio (Ru), vibration frequency (f), and sand content percentage (P) is:* $\boldsymbol{Ru=0{,}2027+0{,}2549.f+0{,}00076.P-0{,}0392f^2+0{,}00109.f.P-0{,}00000229.P^2}$. *The findings confirm that sandy soils tend to undergo dynamic densification, whereas clayey soils experience greater increases in pore water pressure, plastic deformation, and stiffness degradation. The recommended correction factor for subgrade bearing capacity is represented by the following empirical model:* $\boldsymbol{F_k=-2{,}857.10^{-5}.P^2+0{,}008097P+1{,}2303}$. *The study also established a relationship between the erosion coefficient (k_{erosi}) and reduction of subgrade bearing capacity (ΔCBR):* $\boldsymbol{k_{erosi}=0{,}0133.(\Delta CBR)+0{,}546}$. *The findings confirm that heavy vehicles are the dominant factor accelerating subgrade degradation through increased stress, strain, pore water pressure, and reduced bearing capacity. These conditions increase the risks of pumping, fatigue cracking, differential settlement, and reduced service life of rigid pavements. Therefore, rigid pavement design should incorporate the effects of dynamic vehicle loading and subgrade degradation*

by utilizing the developed mathematical models to achieve more realistic, safe, and sustainable pavement designs.

Keywords: *rigid pavement, subgrade bearing capacity, dynamic vehicle loading, vibration amplitude, vibration frequency, erosion factor.*