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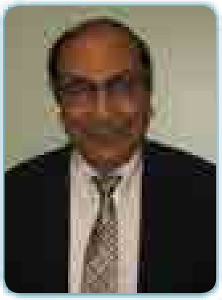

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Influence of road surface and vehicle dynamics on bridge design

The impact factor for moving vehicles on a bridge is calculated by the AASHTO formula: I=50/L+125, where 'I' is the impact factor with a maximum value of 30%, 'L' is the length in feet of the portion of the span that is loaded to produce maximum stress in the member. Impact factor given by AASHTO depends only on the span length of the bridge, whereas road surface profile, weight, speed, dynamics of a vehicle and bridge geometry all affect the impact factor when moving loads are traveling on a bridge. We conducted a study to calculate the increased forces that act on a bridge deck by considering the road surface roughness and vehicle dynamics for an AASHTO HS20-44 truck at various speeds. The vehicle is considered running on a very good road whose roughness is found by using the power spectral density function. The AASHTO truck is modeled as a 12 degree of freedom system to consider the vehicle dynamics. The AASHTO truck is modeled to contain five rigid masses of tractor, trailer and three masses of steer, tractor and trailer wheel axles. The equations of motion are derived using Lagrange's formulation consisting of the masses, the damping and spring forces in the suspension systems of the axles and in the tires. The equations of motion are solved using the road surface roughness and the vehicle dynamics to give the tire forces that are coming on the bridge deck. The dynamic tire forces so calculated are higher 24.72% for the trailer axle tires to 51.70% for the tractor axle tires than the static tire forces due to the weight of the truck only when the speed of the vehicle is increased from 40 to 90 mph (64 to 144 km/hour). Bridge decks act differently in longitudinal and transverse directions because of their structural configuration and hence can be modeled as orthotropic plates. The dynamic tire forces are used to find the maximum vertical deflection in the center of a T-beam bridge deck when the AASHTO vehicle is moving at different speeds by using the orthotropic plate theory and finite element method. The static deflection is also found for the corresponding point of the bridge. The increase in the vertical deflection considering road surface roughness, vehicle dynamics, speed and the bridge geometry is used to find the impact factor. The impact factor varied from 36.81% to 43.96%, whereas the impact factor from the AASHTO formula is 21.05% for the bridge considered, which is smaller than the impact factor if all the factors involved were considered.

Biography

Sukhvarsh Jerath has obtained his PhD from the University of Illinois, Urbana-Champaign in 1977. He is currently a Professor and Chair of the Civil Engineering Department at the University of North Dakota, USA. He has also done research at the US Army Construction Engineering Research Laboratory (CERL) and Oak Ridge National Laboratories (ORNL) for short period of times in addition to consulting for the industry. He is a Fellow of the American Society of Civil Engineers (ASCE) and Professional Engineer in the states of Illinois, Indiana, Minnesota and North Dakota. He was selected as a Fulbright Scholar by the US State Department, Washington, DC from December 2014 to May 2015 to teach and research at the Indian Institute of Technology Bombay (IITB), Mumbai, India. He is currently writing a graduate level text in structural stability.

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