There are over 600,000 bridges in the United States, traversed by hundreds of millions of vehicles every day. The manner in which the bridges react to those vehicles is not well understood, and although decades of research have helped to reduce that knowledge gap, the most apparent conclusion has been that a bridge’s response to moving vehicles is complex and dependent on numerous and interdependent factors. Despite this, design and evaluation specifications provide the means to account for the dynamics of moving vehicles by amplifying vehicle loads by a prescribed factor during analysis. These factors may have been sufficient in the past, but as design codes become less conservative and new loading scenarios are made possible by burgeoning technologies, the current approach may no longer prove adequate.

Vehicle-bridge interaction (VBI) is the name often given to the dynamic behavior of bridge and vehicle and is used in reference to the principles that govern it. The interaction can be described generally as a process whereby the kinetic energy of the forward motion of the vehicle is directed into the bridge. As a vehicle moves over a road surface that is not perfectly smooth, the vehicle must move up and down and may even begin to “bounce” as the vehicle’s natural modes of vibration begin to resonate. The vertical motion of the vehicle is resisted by the bridge and thus imparts varied forces with peak amplitudes in excess of its weight. Furthermore, the persistent and varied loading gives momentum to the mass of the bridge, thereby exciting the bridge’s natural frequencies.

Therefore, in addition to the weight of the vehicle, the bridge also experiences force due to the “bounce” of the vehicle as well as force due to the movement of the bridge mass. While much study has been conducted on the factors that affect the overall amplification, this research will seek to first understand the mechanisms behind both of those amplification components before identifying conditions that maximize each component. Further investigation will examine which component contributes most to the bridge response, realizing that it may likely change, depending on the structure, loading conditions and location of response. This knowledge will provide the means of identifying structures that are more likely to experience unusually high dynamic amplifications and those characteristics that should be avoided or corrected, as well as vehicle types and traffic conditions that exacerbate amplifications. Special consideration will be paid to repeated vehicles (i.e. platooning) and their effect on a bridge’s dynamic response.