One of the primary issues for both the design and assessment of highway bridges is whether a structure can adequately resist extremes of traffic loading. Whereas the condition and structural integrity of a bridge can be assessed to a reasonably accurate degree, the critical levels of applied traffic load are difficult to quantify and are subject to significant levels of variability. The presence of dynamic interaction between the bridge and the crossing heavy traffic further increases the difficulty of accurate assessment of the total load effect experienced by the structure.

The concept of developing traffic load models based on recorded truck population data is well developed, and when used with extreme value theory offers the most widely accepted method whereby the characteristic static load imposed on a bridge is estimated. The computational expense required to incorporate vehicle bridge interaction renders the use of a similar approach to determine characteristic total load effect prohibitive at present. Therefore it is common that a generalised dynamic amplification factor (DAF) based on only a few bridge specific parameters, be applied to the characteristic static load effect to estimate characteristic total load effect. This decoupled approach is generally considered to be conservative, since in particular the reduced probability of the two extremes occurring simultaneously is not recognised (see Figure 1).

This research has the broad objective of combining statistical analysis of bridge traffic loading with vehicle bridge interaction techniques with the aim of improving the assessment of bridge total load effect allowing for dynamic interaction. Studies into the influence of transverse vehicle location and the proximity of preceding vehicles on dynamic interaction are also included. The work focuses mainly on short - medium span bridges with two opposing lanes of traffic.

Finite element bridge-vehicle interaction models offer the most comprehensive theoretical approach to the assessment of total load effect. By using these 3-dimensional bridge and vehicle models, a representative sample of critical static loading scenarios are analysed dynamically to develop the relationship between static load effect and total load effect at the upper extremes of traffic loading.
A further approach, using simplified vehicle and bridge models, and incorporating the convolution of statistical distributions of some of the more important parameters of the truck population, is also developed to produce exact and fully repeatable results for the respective distributions of both static load effect and total load effect. Figure 3 illustrates the total bending moment, including dynamic effects, for a range of velocities and Gross Vehicle Weights (GVW). Since the probability of occurrence of all combinations of velocity and GVW is known, it is possible to determine the exact probability of the bending moment capacity being exceeded.

By comparing observed characteristic values of static load effect and total load effect a site-specific allowance for dynamic interaction may be prescribed which could potentially prevent unnecessary bridge maintenance and result in significant monetary savings.