# Fatigue equivalent loads for visualization of multi-modal dynamic simulations

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***Abstract:*** *Transient dynamic simulations gain importance in the automotive industry and modern fatigue postprocessors are apt to evaluate the fatigue damage. However, additional insight into a structure's behaviour may be obtained from observing the displacements. Displacement patterns are important for design engineers in order to improve the structure. With proportional static loads it is trivial to display and understand the displacements, but the displacements in dynamic simulations are often very complicated. This paper describes a novel method for visualising the transient displacements of mode-based analyses. Based on the modal displacements a new simple, yet fatigue equivalent, modal displacement is computed and visualized instead. Applications from commercial vehicles are used as examples.*

***Keywords:*** *modal dynamics, equivalent load, fatigue, post-processing, Basquin's law*

## 1. Introduction

The displacement history of a finite element model of an arbitrary structure may be expressed as a linear combination of fixed displacement vectors multiplied with scalar time varying functions. In many engineering applications it is possible to discern a few displacement vectors that adequately span the entire displacement space. Typically the first few eigenmodes of the structure are sufficient. This paper is concerned with fatigue loads on vehicle components and for this type of application a linear representation with only a few eigenmodes is often sufficient to represent the entire displacement history.

Modern fatigue post-processors, whether strain- or stress based, are capable of evaluating the fatigue load from a time varying linear combination of fixed vectors. The fatigue damage is computed as a local damage on a critical plane in every point/node of the structure. As an example; for a number of vectors in the order of $10^1$ and a number of nodes in the model in the order of $10^6$, the time for fatigue evaluation is counted in hours on an ordinary computer. This type of fatigue evaluation of linear dynamic simulations is currently a regular routine at many companies in the vehicle industry.

However, the fatigue life of a component is not alone sufficient for developing new engineering solutions. If only a weak point is indicated the remedy is usually to add more material (read cost