Elastodynamic analysis of the desmodromic valve train of a racing motorbike engine by means of a combined lumped/finite element model

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Received 14 January 2006; received in revised form 8 June 2006; accepted 11 June 2006
Available online 1 August 2006

Abstract

A combined lumped/finite element model of a portion of the desmodromic valve train of a racing motorbike engine was developed and validated in order to simulate the elastodynamic behaviour of such a particular timing system. The model includes the lumped parameter model of the belt transmission that drives the camshafts, the finite element model of the camshafts, and the lumped parameter model of two cam-valve mechanisms (one for each camshaft). The procedure to validate the model, based on experimental tests carried out on a test bench described here, is presented and discussed. The comparison between the numerical results and the experimental data shows that the effectiveness of the model is satisfactorily achieved. It will be possible, in a further study, to add the other cam-valve mechanisms and the missing external forces, in order to obtain a complete system model. Some possible applications of the presented model are provided in order to show how the overall model could be employed to perform both design optimisation and diagnostics.

Keywords: Desmodromic valve train; Elastodynamic model; Lumped parameter model; Finite element model; Experimental validation

1. Introduction

When a mechanism operates at a high speed, its dynamic behaviour is affected by the link elastic flexibility, the mass distribution and the effects of non-linearities such as backlashes and friction in joints. The resulting motion of the links may be influenced so greatly that the mechanism could fail to perform its task properly. In addition, high accelerations and dynamic stress may occur, causing early fatigue failure and high levels of vibration and noise. The development of an elastodynamic model of the mechanism allows the estimation of the actual dynamic forces, impacts and mechanism performance, as well as design optimisation and fault diagnostics. Great attention is in fact paid to the elastodynamic simulation of high-speed mechanisms [1–5].