Orthodynamometer for Measurement of Longitudinal and Transverse Loads in Wind Tunnel Testing

Wragg Freitas, A.[1], Gil Morais, P.[1]
[1]Scientific Instrumentation Centre, National Laboratory for Civil Engineering, Av. do Brasil 101, 1700-066 Lisboa, Portugal
email: afreitas@lnec.pt, pmorais@lnec.pt

ABSTRACT: This paper describes the development of an orthodynamometer to measure longitudinal and transverse loads in wind tunnel testing, and its application to tests of a light weight high speed train model. One of the aims of these tests was to assess the differences in the aerodynamic behaviour of the model resulting from minor changes purposely introduced on its surface. The existing force measurement devices proved to be inadequate for such assessments, which demand very high resolution and low uncertainty. The orthodynamometer developed is based upon the deformation of a parallelogram aligned with the model's longitudinal axis. The resulting displacements, measured with two LVDT, are proportional to the applied loads. All the joints are elastic and the LVDT cores are contactless, as to minimize the effects of dissipative forces. The stiffness of one of the joints is adjustable through the variation of the distance between its traction and compression elastic elements, allowing for the use of the whole measurement range of the longitudinal LVDT according to the maximum expected longitudinal load, thus maximizing resolution and accuracy. The two LVDT and their cores are positioned as to minimize the cross-influence of the two axes. The longitudinal LVDT that measures the displacement of one of the top joints is positioned in a location far from it. The displacement is transmitted through an INVAR wire. This arrangement is used to accommodate the very small vertical and transverse displacements of the joint and minimize its influence on the longitudinal measurement. The transverse LVDT has its reference frame located on an intermediate component of the main joint as to measure only the transverse displacement of that same top joint. Results so far obtained reveal the orthodynamometer's behaviour is nearly linear and has high repeatability.