

**FEA-BASED METHOD TO PREDICT DYNAMIC TEST  
FAILURES OF INDUSTRIAL RUBBER CASTOR  
WHEELS**

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## **Declaration**

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## **Abstract**

Castor wheels are used in various applications including industries, hospitals, offices, shopping trollies, air ports and other material handling applications. These applications demand different properties from castor wheels, such as dynamic load capacity, high speed capability, and capability to operate in hot and cold environments. Design of a castor wheel plays a major role to fulfill those various demands while being competitive in the market. Dynamic test of castor wheel is one of the main tests done on new castor wheel designs to evaluate its performance for an application. Due to manual trial and error practice used to test new designs in dynamic test, wheel development cost and lead time for deliver new castor wheel designs for new customer requirements is high. In order to evaluate wheel designs in early stages of development in dynamic test performance, Finite element model was developed to check castor wheel dynamic performance using combination of finite element analysis (FEA) techniques and raw material testing.

Initially six samples of castor wheels were selected and dynamic test was carried out on them at various loads to evaluate temperature development inside the wheel and failure modes. Two sets of raw material testing, namely uniaxial tensile test and dynamic mechanical analyze test (DMA), were done on rubber and plastic materials which are used to make castor wheels. One wheel was selected as a case study to develop FEA model. As first step, 3D static loading simulation was done for the selected wheel. Total energy rate was defined for wheel in dynamic motion by data from static test using equations. 2D axisymmetric FEA model was developed as next step to evaluate temperature development of the castor wheel. Calculated energy rate was distributed among rubber elements as heat sources combining with DMA results to predict temperature inside the 2D profile using transient heat. Wheel failure analysis was carried out by combining predicted temperature profile and static loading case with temperature dependent properties of materials used. It was defined as a good design if castor wheel shows higher safety factor in failure simulation. From the case study, step-by-step method was developed to simulated castor wheel designs and evaluated failure. Four castor wheels were simulated according to developed model and predicted temperatures were compared with actual dynamic test temperature to validate the proposed model which showed good match with practical data. As future work, advanced failure analysis of caster wheels can be proposed, which should be carried out considering material chemistry and behavioral changes of materials with heat and fatigue loads.

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