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DYNAMIC ANALYSIS OF 3D LANDING GEAR MODEL WITH POSSIBLE FLAW

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ABSTRACT

Aircraft landing gear is considered one of the most critical systems for at least two reasons, i.e. operational safety and that of carried people and cargo. Great instantaneous forces arise in structural components of the landing gear during the touchdown. These forces need to absorb and dissipate the energy of fall. The aeroplane designed and operated according to aeronautical standards, nowadays in force, should in a safe way absorb the portion of energy due to the aircraft fall while on landing, and that of energy generated due to the horizontal movement on the surface. The greatest loads that affect the landing gear result from either the absorption of vertical-fall energy. Proper selection/adjustment of landing-gear characteristics is a very intrinsic issue [2-5]. However, properly adjusted characteristics enable minimisation of loads that occur in the landing-gear components at the moment of touchdown. Therefore, dynamic analyses of the landing gear are conducted to provide capabilities to forecast their behaviour under hazardous conditions. This kind of investigation with numerical methods applied is much easier and less expensive than stand tests.

The FEM model of the main landing gear has been developed using four types of finite elements, i.e. hexagonal elements, tetragonal elements, shell elements and rod elements to describe the damping system located in the cylinder. To describe material properties of all mechanical components (such as: the piston body, the piston cylinder, the pilot sleeve, pins, the connecting rod, wheel rim and suspension arm), a materials chart describing parameters for the elastic-plastic range was used. The surface-type contact was defined between all mating components of the landing gear. One of the most fundamental problems faced in the course of studies was how to describe behaviour of the damping system located in the landing-gear strut. To do this, a mathematical finite element was implemented. These element enable, by means of suitably verified mathematical equation, description of how an actual oleo-gas damper affects the landing gear under landing conditions. In the developed numerical model of the landing gear account was taken also of the support-wheel-related subassembly, which includes such elements as: the wheel pin, the wheel rim, and the tyre. All parts of this subassembly,

belt in the tyre excluded, were represented with the flexible hexagonal elements. Four-node shell elements were used to describe the belt itself. This enabled the non-homogeneous layers of the tyre cord (that are to be found throughout the tyre cross-section) to be identified using the composite-dedicated materials chart. In this model the airbag is treated as a control volume. The volume is defined as the volume enclosed by a surface. The area of the control surface which surrounds analysed volume is related to the control volume according to Greens's theory. The rubber components of the tyre, such as a tyre tread and tyre sides, a material model of rubber (based on the Mooney-Rivlin theory was applied.

The FEM model of the landing gear was applied to determine efforts of individual structural members while simulating the landing-gear drop, and to investigate how the energy of such a system changes; also, to find what kinds of deformations occur in individual components, and to investigate into the effectiveness of the damping system. At the initial stage of the tests given consideration, numerical tests were performed to simulate the drop of the structure. Calculations were made using the so-called direct-integration procedure, colloquially called the 'explicit integration'' [1].

Results gained from the simulation have proved how effective the 3D numerical model is and how many problems can be solved in the course of only one numerical run, e.g. the geometric and material non-linearities, the question of contact between mating components, investigation into kinematics of the landing gear, and investigation into the problem of dissipation (change) of energy in the whole system and the checking of possible failure influence on the structure behaviour, which can appear in some elements due to overload. The major advantage of the presented numerical method is applicability thereof to landing gear examination/testing with artificially introduced flaws, what is impossible to be performed with other methods, including experimental testing work. This might include investigation into states/conditions hazardous to the operation of the landing gear. Furthermore, the method enables optimisation of values of some selected physical quantities of the landing-gear.

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