THESES

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1. I developed a dynamic modelling procedure to explore stresses generated in bus body frame structures built of hollow sections (prismatic rods). Using a procedure consisting of the generation of a simplified flexible body frame structure by Component Mode Synthesis, the multibody analysis of the vehicle model with a flexible superstructure, and the structural transient FE test of the simplified body frame structure model locally extended by detailed geometry, calculation time can be reduced by one order of magnitude compared to presently used methods exclusively based on FE calculations for determining stresses generated in the body frame structure. [GB-1]

2. For a real bus, I generated calculation models of various degrees of detail, characterized by an axle consisting of rigid bodies, a body frame structure consisting of beam elements and locally of shell elements, which are suitable for determining the stress state of the junctions examined on the body frame structure. I used the models to explore in detail the stress and deformation states of the vehicle's junctions examined and their change in the course of time. I used measurement results to verify the practical applicability and reliability of the calculation method and the models. [GB-1, GB-2, GB-13]

3. For elements constituting a multibody model of the bus examined, I studied the effect of approximations and neglects applied in the course of generating the model to the dynamic behaviour of the body frame structure:

   3.1. I determined the effect of superstructure models of various degrees of structural detail, used in multibody calculations, on stresses generated in the body frame. I stated from the calculation results that in the course of multibody calculations, a detailed model also including the stiffening effect of plating and fixed glazing yields the results best corresponding to measurement results. [GB-1]

   3.2. I concluded from the result of mass distribution tests of the vehicle superstructure that the glazing and concentrated masses do not need to be modelled for examining the stress state of junctions, if they are located far from the junction examined.

   3.3. In regard to the approximation of the mass matrix of the flexible superstructure, I concluded that in the course of multibody calculations, the effect of considering or neglecting invariants outside the main diagonal of the matrix to the stress state of the superstructure is negligible, with a view to the fact that taking them into consideration causes differences of two orders of magnitude less as compared to the stresses calculated.

3.4. In the course of the calculations related to the approximation of the characteristics of discrete springs and dampers within the multibody model of the bus examined, I explored the stresses generated in the body frame structure and their changes in function of the approximation of characteristics. I concluded from the calculation results that neither linear, nor bilinear approximation are suitable for the approximation of discrete element characteristics in case of high-amplitude deterministic excitation. Satisfactory results can only be achieved by applying an approximation which is more accurate than linear and bilinear description (e.g.: spline). [GB-2]

3.5. I concluded from the calculations performed that in the course of dynamic modelling, taking the vehicle superstructure into consideration as a rigid or flexible body has a greater effect on the stress values yielded as result of calculations than the approximation of discrete element characteristics. [GB-2]

3.6. I verified by calculations that the glass – adhesive layer – body frame structure model used in practice, describing the adhesive layer by shell elements, can also be used when specifying stresses generated in the body frame structure more accurately. [GB-13]

4. I developed a method for the dynamic analysis and synthesis of the vehicle structure. The essence and purpose of this method is to calculate specific deformations and stresses changing/alternating in time in terms of magnitude/meaning, generated as a result of dynamic loads; furthermore, to explore locally emerging plastic deformations and the accompanying own stress system; and to determine real resultant deformations and stresses, with particular regard to the weak points of stress concentrating cross-sections (junctions).

- The dynamic synthesis proposed, based on the use of a linear and nonlinear material model, can essentially be used favourably to calculate real deformations and stresses remaining in the weak points of stress concentrating cross-sections and resulting from taking them into account The numerical procedure presented yields more accurate and more reliable results than before. These can be used for the structural, rigidity, and fatigue analysis and evaluation of vehicle structures with low input of time and costs.

- The reliability and practical applicability of the method developed and proposed, which approaches the reality to a greater degree and integrates load, structure and material models, are verified by the comparison of results yielded by experimental measurements and the numerical procedure, more specifically, by the good correspondence of acceleration and strain figures measured and calculated for reference points.