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COMMENTS AND PROPOSAL TO REGULATION NO. 66, ANNEX 9

Transmitted by the expert from Hungary

When the Ad-hoc Expert Group (AHEG) presented the new version of Regulation No. 66. to GRSG the Hungarian delegate made a reservation regarding annex 9 (Computer simulation of rollover test on complete vehicle) having some doubts about the draft accepted by the majority of AHEG experts and proposed to GRSG. The expert from Hungary promised written comments and proposal for the next GRSG meeting.

Meetings in Hungary

Three meetings have been organized to discuss the major questions of the computer simulation as a possible approval method in Regulation No .66 (the subject of annex 9).

1. Common meeting of Vehicle Division and Structural Analysis Division of the Scientific Society of Mechanical Engineers (**GTE**) 3 December, 2003, 16 participants.
2.
3. Official meeting of the Machine Structures Committee of the Hungarian Scientific Academy (**MTA**), 17 February, 2004, 14 participants.
4.
5. Meeting at eCon Engineering Ltd, small engineering company working on the field of computer simulations, calculations, structural analysis, 25 February, 2004, 7 participants.
6.

All the three meetings started with an introductory presentation of Regulation No. 66 and the rollover process to be simulated which was followed by a long (3-4 hours) discussion.

Conclusions of the meetings.

It was generally agreed that the computer simulation is widely used, very useful and effective method in the product development stage. Good programs and appropriate hardware are available. However strong concerns were expressed as regards its use for type approval. The major difference between the two kinds of use:

- in the development there is only one interest (the interest of the manufacturer) which controls the whole work, the whole process. There is no possibility of a conflict.

- in the approval there are two interests: the essential interest of the manufacturer (to approve the vehicle) and the interest of the authority (to respect the requirements of Regulation No. 66.). The possible conflict between these two interest shall be considered.

The computer simulation of the rollover test of a complete buses may be used for type approval only if this conflict can be avoided or minimized (down to the level of the other approval test methods of Regulation No. 66).

Some interesting ideas, comments, questions, proposals, experiences coming out from the three discussions are reproduced below:

GTE meeting

- The program to be used for the simulation must be able to handle non-linearity in material low, non-linearity in geometry, energy and energy balance calculation, contact problems including friction, damping, dynamics (mass forces) and it has to be validated.

- Theoretically two kinds of program may be considered: very general programs (e.g. ANSYS, ABACUS, NASTRAN, etc.) and very specific programs developed only for this rollover process. Different approaches, different advantageous and disadvantageous, different dangers.

- The program must be available on the market without any limitation (e.g. at least in five countries) and shall be scientifically validated (e.g. on international level at least by five different users).

- The engineering group making this simulation for approval must be earlier accredited at least on national level.

- The transparency of the simulation is essential, inside controls are necessary.

- For of the mutual recognition of the approval, the input and output data must be well specified, standardised.

MTA meeting

- The material low(s) to be used is (are) questionable: how to determine it (them), there is no enough information about the compression, (only tensile test results are available for the structural materials used in body construction), about fracture criteria, the welding (different types of welding) is a black horse from the point of view of the material low, etc.)

- The programs available today are not appropriate to run the dynamic simulation process and to generate parallel the plastic hinge (PH) characteristics formed on the structure. In the case of simple rings in the structures, 60-80 PH-s (20-30 different types) should be considered, in the case of special, reinforced rings in the structures, 15-20 special, complex PH characteristics should be generated inside the simulation. It was agreed that today it is an unsolved problem.

- The location of PH-s in the structure may not be determined by the computer because it strongly depends on the type of the finite elements (rod like, shall, solid body, etc.) on their size, on the density of the net.

- The reliability, repeatability of the calculation also strongly depends on these features of FEM, mentioned above.

- The buckling (loss of stability) is not equal with the traditional yield (elastic buckling also exists) and it strongly depends on the local geometry, and the formation of a PH starts with local buckling.

- The transition between the rigid body rotation and the large scale structural deformation strongly depends on the modelling of the dynamic contact between the roof and the ground.

eCon Engineering meeting

- Several PH characteristics were generated earlier by FEM on simple rectangular steel tubes. The first results in each case strongly differed from the measured characteristics. Modifying the elements, the net, the boundary conditions, etc. in more steps, the measured characteristics could be reproduced.

- Significant differences were shown using rectangular tube model (sharp corners, edges) or using rounded model (radius at the corners)

- Calculating the absorbed energy (only special finite elements are appropriate for this purpose) the program provides the energy in every individual finite element. To get the sum of these "energy elements" (the absorbed energy by the PH), the geometrical size of the PH, that means the considerable volume of the finite element shall be determined by somebody, somehow.

- In the case of one PH calculation the output (result) file is approximately . 20 times larger than the input (geometry) file. It could raise hardware capacity questions.

- It is not an easy task to realise in the simulation that the deformed structure or any rigid structural element contacts the survival space, especially if its shape (position, contour) is changing alongside the length of the bus.

General conclusion and proposal

Basic starting points:

a) The computer simulation – as an approval test method – basically differs from the other methods. Much more complicated, sophisticated, very special engineering knowledge is needed to work with and to control it.

b) The average engineering knowledge and software-hardware capacity of the technical services – which are absolutely sufficient for other approval methods of Regulation No. 66. – are generally not enough to handle and control the computer simulation method.

c) Only well defined, precisely specified, unified simulation method (having inbuilt self controls) may be used in the international approval process to avoid the possibility of the conflict between the two different interests, mentioned above.

During the three meetings held in Hungary, a lot of questions were raised, proposals were made. They should be considered before accepting annex 9 to Regulation No. 66. Therefore the possible solutions could be the following:

- Discuss and finalise the improved Regulation No. 66.
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- Keep annex 9 in the regulation with the title on an empty page saying "to be developed".

- According to the WP.29. supported Hungarian proposal, the scope of Regulation No. 66. should be extended to all kind of buses. This work could be made in AHEG.

- Parallel to this work a good annex 9. could be worked out, also in AHEG.

- These drafts made by AHEG are to be discussed and finalised in GRSG.

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