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TRANSMISSIBILITY OF SUSPENDED SEAT LOADED WITH PASSIVE MASS AND WITH HUMAN DRIVER - DISCUSSION

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Abstract: *Person sitting on a suspended seat, which is excited by floor motion (f.e. truck cab floor), plays a passive as well as an active role in influencing own vibratory motion. Transmissibility of floor vibration to a person, occupying a suspended seat, differs therefore vastly from transmissibility of floor vibration to a passive seat load. Identification of these human reactions could be important, as it could alter vibratory comfort criteria as well as demands on active control of suspended seats. Some hints for further research, which could lead to the identification of force reactions of a person sitting on a suspended seat excited by vibratory floor motion, are discussed.*

Keywords: ***Suspended vehicle seat, vibration transmissibility, human reactions***

Measurements of suspended seat transmissibility, carried out in laboratory with passive load and with real driver in a truck, showed marked discrepancy of the results Apetaur et al. (2009). (Remark: transmissibility is here defined as frequency dependence of the ratio of body amplitudes to floor amplitudes.)

Person, sitting on a suspended seat, can alter consciously or unconsciously his/her vertical position relatively to the floor. This is possible on non-suspended seats to very small extent only because of the limited elasticity of the seat cushion. Activity of the person, which is sitting on a suspended seat, leads to profound change of the seat+person dynamic system in comparison to seat+passive load dynamic system.

Two questions arise evidently:

- if a person influences very substantially own motions on the suspended seat, it must use for it some muscular as well as mental energy; is it then correct to judge its vibratory comfort on a suspended seat by measuring its vertical acceleration only, as it is commonly done to-day ?
- optimization of the transmissibility function of a suspended seat loaded with passive load alone evidently does not express real development task on the dynamics of controlled suspended seats in transport vehicles; is it possible to state the demands on dynamic properties of a suspended seat respecting the actual driver´s/passenger´s reactions?

Identification of sitting person´s reactions, i.e. of the forces exerted, of their origin and their mathematical description would be needed to answer both of these questions.

Identification in narrower sense is meant as determination of functions governing relations of kinematic inputs to the sitting person and forces produced by it. A very crude attempt, described in the paper, was made to state whether such identification seems to be possible at all.

Simple dynamic model was used. It was assumed, that the torso of the person, which sits on the seat, is a passive mass joined to the movable seat structure mass, which is linearilly suspended towards the

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cab floor. This total mass is secondarilly excited by forces, exerted by the person as reactions to the floor motion and his/her own motion.

Transmissibilities seat+driver/cabfloor, gained on three tracks ("1"- good road, "2" – difficult road, "3"- extreme road) by investigations partially described in (Apetaur et al. 2009), were used as basis. They were approximately simplified as indicated on Fig. 1. Curve "4" in this figure represents transmissibility of seat used in the experiments loaded with passive load, as gained in laboratory measurements. It documents how profound is the difference between human loaded and passively loaded seat behavior.

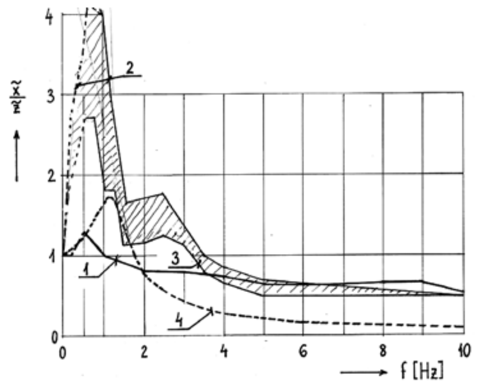

Fig.1 Simplified transmissibilities of seat/driver system measured in on-the-road

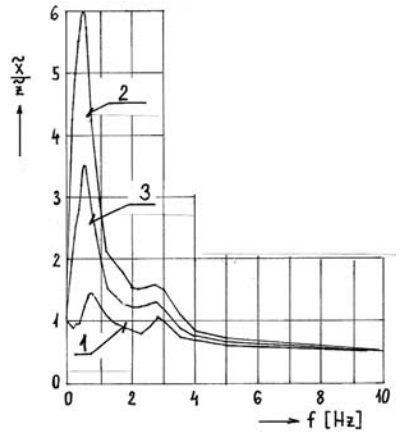

Fig.2 Transmissibilities gained by seat+driver model

Task of the identification (in narrow sense) was to achieve transmissibilities, similar to those shown on Fig.1, by modelling driver´s force reactions as functions of floor motion and of his motion on the seat. This was done purely empirically, trial and error style, by changing inputs, control laws and constants. Result can be seen on Fig.2. It can be said in general, that accordingly to the linear model used:

- reactions of the driver to relatively high frequency floor excitation (over 5 Hz) seem to be caused by floor acceleration mainly;
- driver tries to diminish relative floor to seat movements in frequency range 1 to 3 Hz, seemingly as reaction to relative body to cabfloor motion;
- some destabilizing effect, caused probably by phase delayed body reactions, can be clearly seen around 2 to 4 Hz; this effect seems to be a function of body jerk;
- some so far unexplained driver´s effort increases substantially transmissibility in the range 0.5 to 4 Hz and reaches its maximum at 0.6 to 1 Hz; model shows its dependence on floor vertical velocity, which seems to be strange.

Results shown on Fig. 2 were surprisingly achieved by change of one constant in the seat+body model only.

Though relatively good agreement with real measurements was achieved, the authors warn against generalization of shown findings, as they were gained from very limited and uncomplete set of data. Main contribution of the paper presented can be seen in the fact that it seems to be possible to model mathematically the reactions of a person sitting on a suspended seat excited by floor vibration. Further thorough research would be needed to solve this interesting and practically important problem, dealing with man/machinery interaction. Unfortunately, no support for it was found so far.

References

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