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CONCEPTS AND LIMITS OF THE LIGHT CITY CAR

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The growing impacts of the road traffic in urban areas require the introduction of lightweight compact and mini compact cars, so called city cars. These cars have to provide extreme low emissions and fuel consumption as well as low operation costs. They, also, save parking space as well as dynamic space for traffic, but offer only restricted transportation capacities.

Accident and injury statistics show an inverse correlation of vehicle mass against injury severity in car to car collisions, above all in head on collisions.

Current crash test standards (including FMVSS 208) does not include the require ment for compatibility in collision between cars of different size and weight.

The design of the car structure and the restraint systems, -are-according to current FMVSS and European standards - still being optimised for a collision of a car against one of its kind (impact on rigid barrier) and not against the most probable counterpart it is not satisfactory to design the low mass vehicle only according to current crush test standards.

Different groups started to design and test prototypes and experimental vehicles with respect to compatibility criteria.

Structural compatibility in collisions means that the different cars should deform at the same load level, yielding a length of the deformation zone proportional to the mass of the car, and the frontal structural stiffness of a low mass vehicle must be at least equal or slightly higher than the stiffness of its heavier counter part.

Compatibility in frontal collisions demands significantly different deceleration time curves in rigid barrier impacts for car with different weights.

The results of mathematical modeling of different deceleration - time curves are presented. The best deceleration - time curves corrisponde to rectangular pulse.

A extremely important parameter for the development of the restraint system is the mean deceleration level of the car cabin with its restrain system interface points and surfaces.

The computer simulations show at least a frontal crush length of about 0,3 m is nesessery to handle the 50 km/h fixed barrier impact as well as the car-to-car collision at a closing speed of 100 km/h with a double-weight car. Depending on the number of seats and the arrangment of engine and power, train the minimum overall lengths of city car are 2,05 m for a two-seater and 3,27 m for a four-seater.

The mass ratio and the closing speed to be covered in car-to-car collisions are still open questions.

The different arrangements of the city cars in the phase of study as well as in development in the car industry are shown in this paper.

The city cars are with us and further research and development will be (must be) continued.

The results of investigation encourage and show the justifiableness of the small city car development. Besides the obvious advantages mentioned in the paper, the results of investigation show that the safety car problem can be overcome by application of adequate construction of front car structure and by application of appropriate safety devices.

Kee words: city car, mini-weight, two-seater, four-seater, safty, compatibility, decceleration-model, restrain system.

KONCEPCIJA I GRANICE MALOG GRADSKOG AUTOMOBILA

Veliko opterećenje drumskog saobraćaja u gradovima zahteva uvođenje lakih "compact" i mini compact vozila, koja smo nazvali mali gradski automobil (MGA). Ova vozila treba da imaju ekstremno nisku emisiju izduvnih gasova i potrošnju goriva kao i eksploatacine troškove. Ona, takode, obezbeđuju uštedu u parking prostoru kao i potrebnim površinama za tekući saobraćaj, ali nude ograničene transportne mogućnosti.

Statistika saobraćajnih udesa i povreda pokazuje inverznu korelaciju mase vozila i težine povrede u sudaru dva vozila, naročito pri čeonom sudaru.

Važeći standardni test udara (uključiv i FM VSS 208) ne sadrži zahteve kompatibilnosti pri sudaru dva vozila različitih težina.

Projektovanje strukture vozila i sistema zadržavanja (pojaseva sigurnosti, vazdušnog jastuka) vrši se u skladu sa važećim FM VSS i evropskim standardima - pri čemu se optimizacija vrši kao da se radi o sudaru dva vozila istih masa. Projektovanje vozila male mase ne zadovoljava ako se respektuju samo važeći propisi.

Više timova bilo je uključeno u projektovanje i ispitivanje prototipova i eksperimentalnih vozila s obzirom na kriterijum kompatibilnosti.

Strukturna kompatibilnost u sudaru znači da se različita vozila treba da deformišu na istom nivou opterećenja pri čemu dužine deformacionih zona treba da budu proporcionalne masama vozila. To znači da krutost čeone strukture vozila manje mase treba da bude bar iste krutosti ili nešto veće krutosti od težeg partnera u saobraćaju.

Kompatibilnost u čeonim sudarima zahteva znatno drugačije krive usporavanja pri udaru u barijeru za različite težine vozila. U radu su prikazani matematički modeli za različite krive usporavanja. Najbolje krive usporavanja odgovaraju pravouglom impulsu.

Izuzetno važan parametar za projektovanje sistema za zadržavanje putnika je srednja vrednost usporavanja prostora za putnike i pojedinih tačaka sistema.

Na osnovu kmpjuterske simulacije potrebno je obezbediti najmanje 0,3 m deformacione zone da bi se zadovoljili zahtevi udara sa brzinom od 50 km/h, odnosno sudar dva vozila sa relativnom brzinom od 100 km/h. U zavisnosti od broja sedišta i položaja pogonskog agregata minimalne ukupne dužine gradskog vozila su 2,05 m za dvosed i 3,27 m za četvorosed.

Odnos masa i relativna brzina pri sudaru još uvek su otvorena pitanja.

U radu su prikazane različite dispozicije gradskih vozila u fazi prethodnih studija kao i u razvoju u automobilskoj industriji.

Gradski automobil je tu sa nama, istraživanja i razvoj se nastavljaju.

Rezultati istraživanja ohrabruju i pokazuju opravdanost razvoja malog gradskog automobila. Pored evidentnog niza prednosti, o kojima je u radu bilo reči, rezultati istraživanja, problem bezbednog automobila može da bude prevaziden primenom adekvatne konstrukcije prednje strukture automobila i odgovarajućih bezbednosnih uređaja.

Ključne reči: mali gradski automobil, gradski automobil, mini-dvosed, mini-četvorosed, mini-težina, kompatibilnost, bezbednost, modeli usporenja, sistem zadržavanja.