Shoulder loading of WorldSID 50th

Follow up of discussions in

EuroNCAP & IWG on Pole Side Impact

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Statements from 8th meeting of EuroNCAP WG on Side Impact

Doc. SID-1203-04 on behalf of ISO/WG6, March 2012:

• Proposal to not use shoulder injury risk AIS2+ as a function of shoulder deflection,

• Proposal to not use thoracic injury risk AIS3+ as a function of rib VC for assessment purposes. However this issue is not closed and decisions are expected in November 2012 (as stated later during the EuroNCAP Biomechanics Workshop in July 2012).

Statements from 6th session of gtr on Pole Side Impact

Doc. PSI-06-11, by Audi & VW, June 2012:

• In order to protect the occupants well in a PSI the goal is to direct the loads towards the body regions with greater ability to take these loads while limiting forces on sensitive body areas,

• To give shoulder injury risk reduction a higher priority than sensitive body regions, such as the head and thorax, seems to be a risky approach.

Netherlands' notations during Pole Side Impact meetings

- Shoulder forces at the position of a WorldSID 50th male dummy can possibly be at the position of the upper thorax of a taller occupant,
  - WorldSID 50th male is namely based on the report **report UMTRI-83-53-1, December 1983.** This anthropometric study has lead to a dummy family with a.o. the mid-sized male, but it is based on anthropometric research in the USA dating from the end seventies of the previous century!
  - So this occupant that is said to be taller than the WorldSID 50th male can in fact be easily the human of average stature of nowadays (originating from e.g. Netherlands, UK, Scandinavia),

- Completely deleting criteria at dummy shoulder level can lead to unrealistic high loading at this level.

Questions

- With the human body: how this mechanism of directing the loads towards body regions with greater ability to take these loads, could actually work?
- With dummies: how will this above described mechanism work?
- Will dummies behave biofidelic with regard to this aspect?
- or will dummies behave biofidelic, but only up to a certain value (and then bottom out or give way)?
- How far could the registration of shoulder deflection and/or forces be used to help to reach the best possible thorax protection not only for humans of WorldSID 50th stature but also for humans of realistic stature range?

NHTSA Pole Side Impact Vehicle Tests in PSI-06-12

- NHTSA, Stephen Ridella, provided an interesting set of tests by means of PSI-06-12,
- With exception of one case, cars seemed to perform well on thorax values (next slide),
- However it seems difficult to derive from this dataset some criterion to prevent excessive (i.e. non-biofidelic) shoulder loadings,
- Taking a more simple virtual test could be a way of exploring borders,
- The Madymo facet model of WorldSID of TASS (TNO) and the Madymo facet Active Human Model of TNO could be used to explore differences between humans and dummies.

NHTSA Pole Side Impact Vehicle Tests in PSI-06-12

Vehicle	HIC36	Shoulder Deflection (mm)	Max Thorax Rib Deflection (mm)	Abdomen Rib Deflection (mm)	Lower Spine (G's)	Pubic Force (N)	Pelvis Resultant Acceleration (G's)	Shoulder Force (N)	S-I joint Force (L/R) (N)	Rib with Max deflection	25% AIS 3+ Thoracic Risk	50% AIS 3+ Thoracic Risk	25% AIS 2+ Shoulder Risk	50% AIS 2+ Shoulder Risk	comment
2010 Ford F150	367	38	41	33	57	1110	44	2080	2439/1459	Rib 1	80	71	92	81	curtain and thorax bag
2010 Buick Lacrosse	577	54	43	26	61	1201	87	2270	3533/1952	Rib 1	84	74	100	89	curtain and thorax bag
2011 Hyundai Sonata	250	57	32	44	73	1433	72	2338	3725/1755	Rib 3	63	56	103	91	curtain and thorax bag
2010 Chevy Traverse	439	66	46	36	54	1557	71	2425	3253/1947	Rib 1	89	79	107	95	curtain and thorax bag
2010 Acura MDX	470	62	29	42	54	812	52	2422	3655/1877	Rib 3	56	49	107	95	curtain and thorax bag
2010 Suzuki SX4	195	25	35	42	53	1107	69	1177	4213/2077	Rib 3	68	60	52	46	curtain and thorax bag
2010 Kia Forte	491	55	25	34	46	1151	79	2231	3297/1910	Rib 3	49	43	98	87	curtain and thorax bag
2011 Hyundai Tucson	452	55	35	42	57	936	54	2081	3350/1694	Rib 1	69	61	92	81	curtain and thorax bag
2011 Cadillac CTS	514	51	56	40	57	925	47	2248	No Data	Rib 1	109	96	99	88	curtain and thorax bag
2011 Jeep Gr Cherokee	332	51	30	23	36	1227	58	2017	2651/1520	Rib 1	59	52	89	79	curtain and thorax bag
2011 Ford Explorer	393	60	43	39	81	912	81	2412	4172/2212	Rib 1	83	73	106	94	curtain and thorax bag
2011 Honda Odyssey	413	51	40	41	49	1013	58	1928	3328/1767	Rib 1	78	69	85	75	curtain and thorax bag

Exploring border values by means of virtual testing I

- Taking a more simple virtual test and studying the outcome after applying parameter variations could be a way of exploring borders,

- The Madymo facet model of WorldSID of TASS (TNO) and the Madymo facet Active Human Model of TNO could be used to explore differences between humans and dummies,

- A first task should be to simulate Wayne State University sled tests to compare the two different virtual dummies and the PMHS with each other,

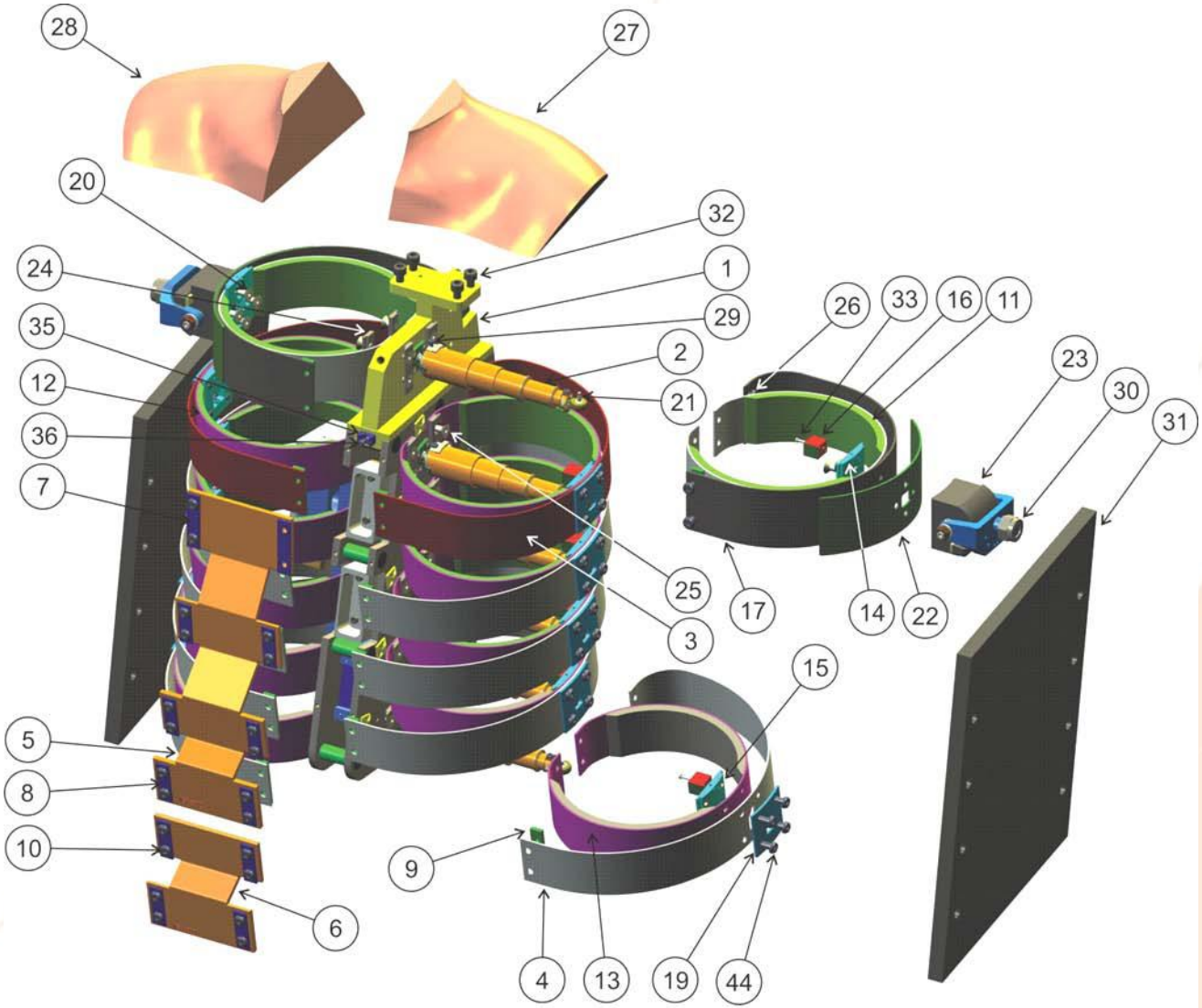
- Next a known APROSYS AE-MDB-test (1500 kg) could be worked out that it will get different variations, without and with direct shoulder loading,

- The comparison of the outcome could bring us closer to acceptable shoulder criteria.

Exploring border values by means of virtual testing II

- TNO has been commissioned by NL-MOT-RDW to study the effect of seating height,

Finding border values by taking account of hardware I



Finding border values by taking account of hardware II

- all IRTRAC's in the previous figure are the same,
- the stroke of an IRTRACC is about 90mm,
- the IRTRACC of the shoulder rib, gains more mounting length at the central plate but looses significantly more mounting length at the positon of the arm fixation (this is the position were the tri-axial accelerometer is found),
- a simple calculation gave an available stroke of 70 mm,
- having this stroke completely consumed, the deflection is believed to be not anymore in the area used for biofidelic testing and because bottoming out could happen the question of durability could even become an item.

Prelimenary conclusions

- The track with the TNO research gave us some trends, e.g. small variations in geometric design (difference of 10% in deformation of an upper door part, and a 30 mm difference in an armrest) results in significant loading of the shoulder up to regions of bottoming out,

- Limits are required to overcome this unwanted situation,

- We recognize the point forwarded in doc. PSI-06-11 (VW & AUDI),

- However when limit(s) are required anyway, we are inclined to think that e.g. for shoulder deflection a value of 70 mm would be appropriate

Thank you for your attention