The new Topcrunch benchmark data CAR 2 CAR for LS-DYNA® MPP971R5

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Abstract

CAR2CAR-ver10 has been used as benchmark data of Topcrunch since 2006. By the enhancement of tied contact in MPP971R5, this data do not work, since the slave nodes of constrained tied contact are released when master segments contain rigid body. CAR2CAR is revised to work for MPP971R5. This paper summarizes tied contact, then explain how to modify the data.

Introduction

Because of the enhancement of tied contact in MPP971R5, the Topcrunch benchmark data Car2car-ver10[1] does not work. In Car2Car, the solid elements are covered by null shell elements. Since the size of mesh between solid and shell are different, shell elements are tied to solid elements by constrained type tied contact *CONTACT_TIED_NODES_TO_SURFCE. Some of solid elements are rigid bodies and by the constrained tied contact slave nodes can not be tied to rigid body. However, until MPP971R4 the slave nodes were tied to rigid body by constrained type contact, and the results looks good since gaps between slave nodes and master segment are zero for Car2car. After MPP971R5, the slave nodes are released when the nodes tied to master segment of rigid body by constrained type tied contact, and job terminated by error. New benchmarl data Car2car-ver20 is modified to work after MPP971R5.

In this paper, first tied contacts are summarized. Then, the modification of car2car-ver20 is described. The modification of other than tied contact is also described.

Summary of tied contact[2]

OFFSET	projection	Tied method		Master segment Rigid body	Orthogonality	TIED_NODES_TO_SURFACE TIED_SURFACE_TO_SURFACE	TIED_SHELL_EDGE_TO_SURFACE
						Degree of Freedum X,Y,Z Master Element Solid	Degre of Freedum X,Y,Z Rx,RY,RZ Master Element Shell, beam
Without OFFSET	Yes	Constraint		No	exact		
OFFSET	No	Constraint		No	exact	_CONSTRAINED_OFFSET (careful use need)	_CONSTRAINED_OFFSET
		Penalty	Incremental Displacement	Yes	good	_OFFSET Option Card D field7 TIEDID=1 (careful use need)	_BEAM_OFFSET
			Total Displacement	Yes	fair	_OFFSET (careful use need)	_OFFSET

Projection : TIEDPRJ option of *CONTROL_CONTACT

TIEDPRJ=0(default) slave nodes project to master surface, and eliminate gaps

=1 bypass projection, Gaps create rotational constraints which can substantially affect results

Orthogonality: exact=Tied constraint does not affect the rigid body motion

good=Tied constraint almost does not affect the rigid body motion

Modification of tied contact

The modifications of tied contact are the following 3 types:

A. Solid is rigid body

   Shell nodes are constrained by *CONSTRAINED_EXTRA_NODES_SET

B. Solid is deformable but some nodes are rigid constraint by *CONSTRAINED_NODAL_RIGID_BODY

   Shell nodes are tied by *CONTACT_TIED_NODES_TO_SURFACE_OFFSET with incremental displacement option

C. Solid is deformable

   Shell nodes are tied by *CONTACT_TIED_NODES_TO_SURFACE

Other Modification

The other modifications are

A. Add spring and dumper elements for suspension as shown in Fig.1.
   These elements are added by Caravan-V07-detail model[3].

B. Among roll_bar and steering gear and their blankets,
   *CONTACT_AUTOMATIC_BEAMS_TO_SURFACE are defined.
   *CONTACT_AUTOMATIC_BEAMS_TO_SURFACE is developed in MPP971R5.

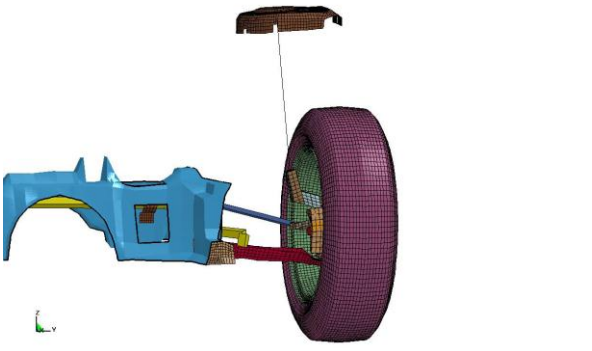

Fig.1 suspension spring and damper added

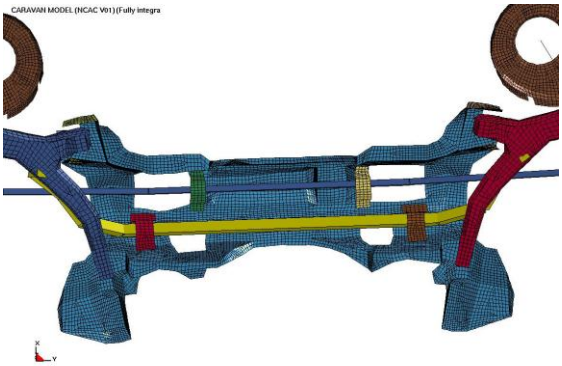

Fig.2 *CONTACT_AUTOMATIC_BEAMS_TO_SURFACE are defined between roll bar and blanket, and between steering gear and blankets

Timing information

	128Cores	256Cores
Total	4h4m39s	3h1m19s
Element calculation	8391s	4565s
Contact calculation	4828s	4539s
Rigid body calculation	1358s	1625s

MPP971R6.1 rev 73149
Intel E5520 with infiniband

Discussions

Penalty type tied contact without offset is missing in LS-DYNA. I would like to ask to add the capability of penalty type tied contact without offset.

The constrained type tied contact can not tie the segment with rigid body. The user have to select the slave nodes which is not tied, and these nodes are tied by penalty type tied contact. This process is inconvenient for users. I would like to propose the following tied contacts;

*CONTACT_AUTOMATIC_TIED_NODES_TO_SURFACE,
*CONTACT_AUTOMATIC_TIED_NODES_TO_SURFACE_OFFSET,
*CONTACT_AUTOMATIC_TIED_SHELL_EDGE_TO_SURFACE, and
*CONTACT_AUTOMATIC_TIED_SHELL_EDGE_TO_SURFACE_OFFSET.

By these automatic tied contacts,

1. Slave nodes tied to master segment by constrained tied contact
2. If master segment has rigid body and slave nodes do not tied by constrained tied contact. The slave nodes tied by penalty incremental displacement tied contact automatically.

References

[1] M.Makino, The performance of Large Car Model by MPP Version of LS-DYNA on Fujitsu Prime Power, 9th International LS-DYNA Users Conference, Computing/Code Technology(1), 2006
[2] Livemore Software Technology Corp. LS-DYNA User's Manual
[3] National Car Crash Center, http;//www.ncac.gwu.edu/vml/models.html