LSDYNA 2D Seat Belt Modeling Guideline

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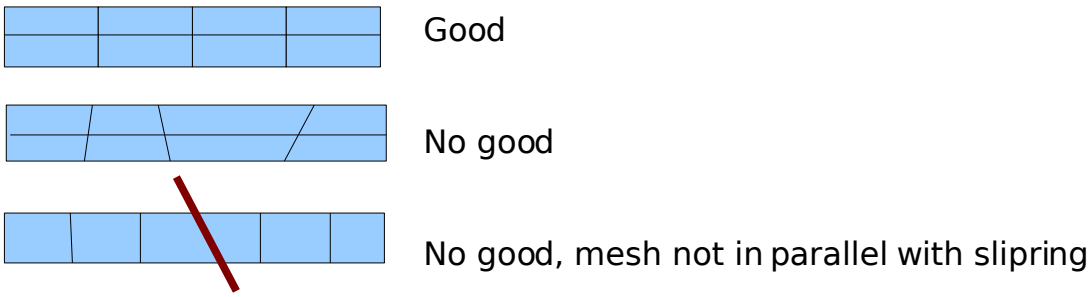
- Applications include
  - modeling the whole belt, Fig.1;
  - replacing **all** 1d sections in a traditional hybrid seatbelt model which uses 1d belt for sections around retractor and slipring and regular shell for contact purpose, Fig. 2~3. Replacement 2d belts will improve contact with dummy. And keeping those regular shell avoids introducing drastic change to existing models.
  - replacing **some** 1d sections in a traditional hybrid seatbelt model, and leaving other 1d sections as they were, Fig. 4. It means, 2d belt can now co-exist with 1d belt to provide users the best flexinility modeling a belt. This allows users to keep 1d belts for some sections which might pose difficulty for meshing 2d belt or are known not to involve any contact at all.
- Result comparison
  Results of hybrid 1d model, Fig. 2, hybrid 2d model, Fig. 3, hybrid 1d+2d model, Fig 4, and pure 2d model, Fig. 1, are compared and displayed in Fig. 5~9.
- Pros and Cons of 2d belt
  - Pros of 2d belt
    - improves contact behavior with dummy
  - Cons of 2d belt
    - needs a good quality of mesh and no 3-node shell is allowed,



    - more expensive than 1d

- INPUT
  1. A part representing a 2D belt needs a *MAT_SEATBELT and *SECTION_SHELL.
  2. The *MAT_SEATBELT is same as that for 1D, except the new input of CSE for 2D belt, the 6rh column. **CSE is recommended to be set to "2"** to trigger new improvements made in the last few months.
  3. *SECTION_SHELL for 2D belt needs the definition of the edge-node set, 8th column of the 2nd card. The edge-node set contains the nodes on one of the edge of a belt. If there exists a retractor, it is the set of nodes coincident with retractor's SBRNID.
  4. To define a 2D belt retractor, SBRNID, the 2nd column of the 1st card, has

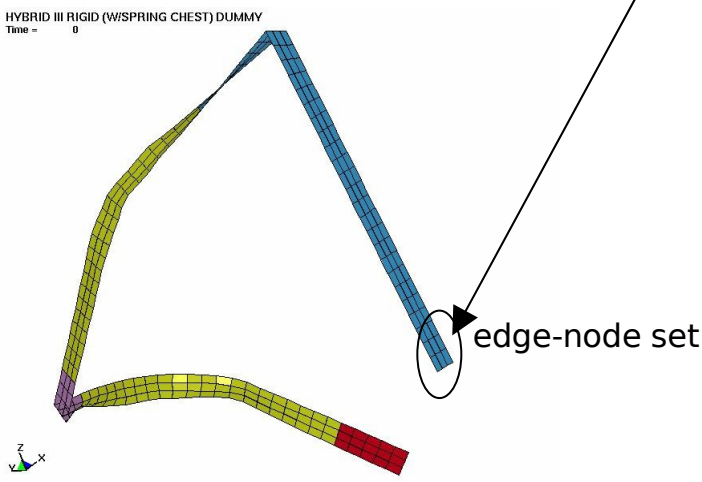
to be the negative value of the node set containing the set of retractor nodes. The nodes in both edge-set node and -SBRNID has to be input in the same sequence. Also, SBID now contains set of 2D belt elements connected to "-SBRNID".

5. 2D belt elements are defined by *ELEMENT_SEATBELT with column 8 and column 9 containing N3 and N4. 2D belt elements have to be as uniform, in both shape and size, as possible.
6. Slipring for 2D belt can be defined through a negative SBSNID, the 5th column of the 1st card. "-SBSNID" is the set of slipring node. Again, it has to be input in the same sequence as "_SBRNID" and "edge-node set".

Messages in d3hsp (available in R4 & R4.2, not R4.2.1 or older)
All 2d-belt related messages are now printed/echoed using ID input by users, instead of IDs of internally created 1d belts.

- OUTPUT
  - Belt force of 2d belt can be yielded by using *DATABASE_CROSS_SECTION
  - output of 2d Retractor and sliprings are now available in sbtout
  - output of internally created 1d belt, retractor and slipring can be recovered by setting "ip1dblt", the 7th column of the 2nd card of *CONTROL_OUTPUT, to "1".

***PART**
Blue Part
20037 2111120 20037 0 0 1 0 0
***SECTION_SHELL_TITLE**
Section for the 2d belt
2111120 9 0.0 3 0.0 0.0 0
$ edge_node
1.2 1.2 1.2 1.2 0.0 0.0 0 2003292
***MAT_SEATBELT_TITLE**
MAT_SEATBELT w. Compression for 2d belt part
$ COMP
20036 5.9700E-08 849003 849013 1.5 2



```
*ELEMENT_SEATBELT_RETRACTOR
$#   SBRID    SBRNID      SBID       SID1      SID2      SID3      SID4
  2000001 -2000001   2000100   2000001         0         0         0
$#    tdel      pull        LC       ULC      lfed
         0         0   2002000   2002001        20
*SET_SHELL_LIST
  2000100
  2003037   2003074   2003111   2003148
*SET_NODE_LIST
  2000001
  2013292   2013293   2013291   2013294   2013295
```

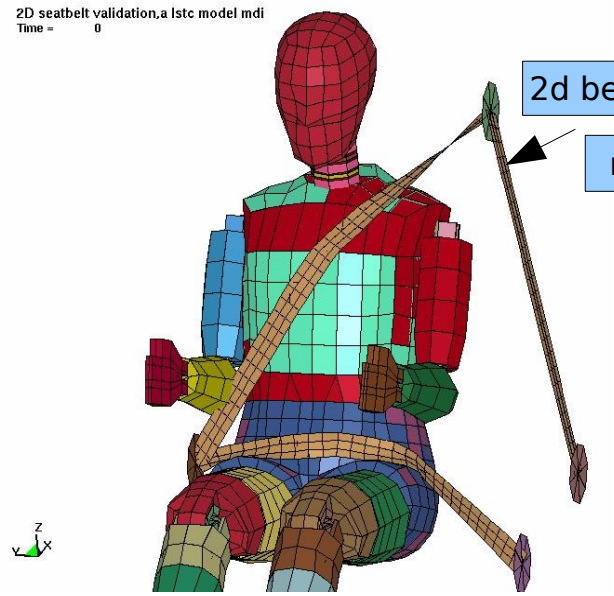


Fig. 1 A model using pure 2d belt

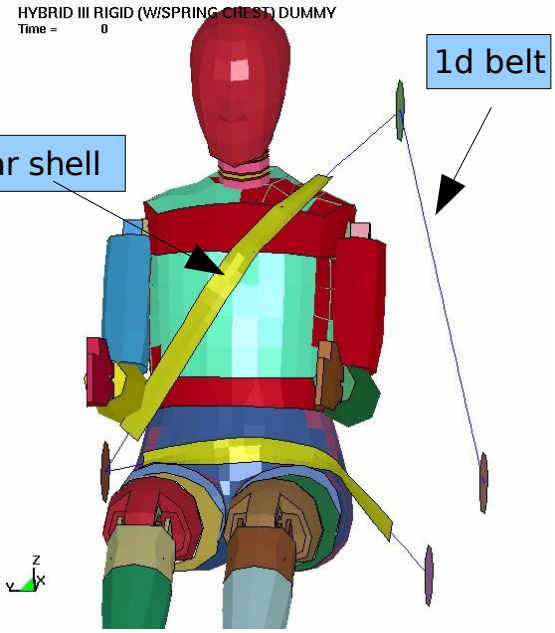


Fig. 2 Traditional hybrid 1d model

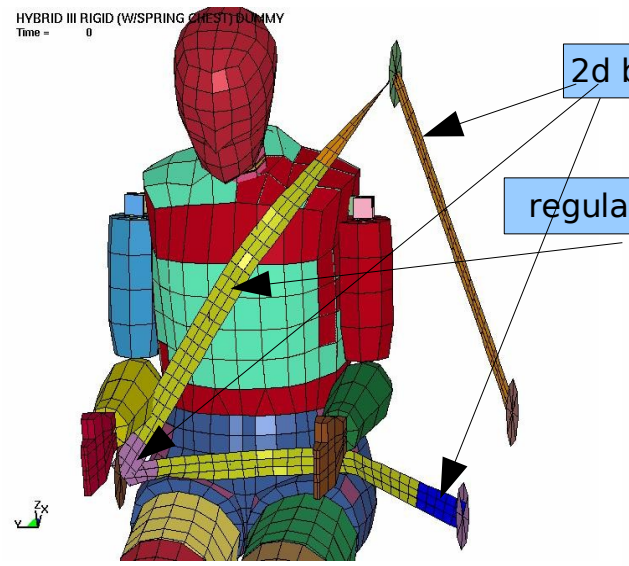


Fig. 3 Hybrid 2d belt

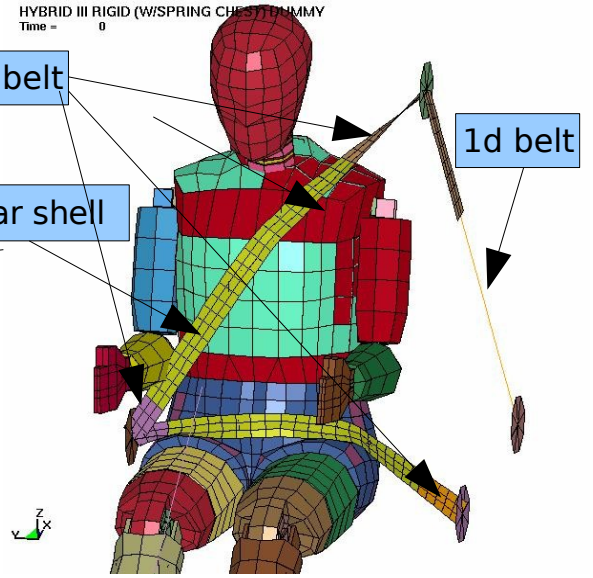


Fig. 4 Hybrid 2d+1d model

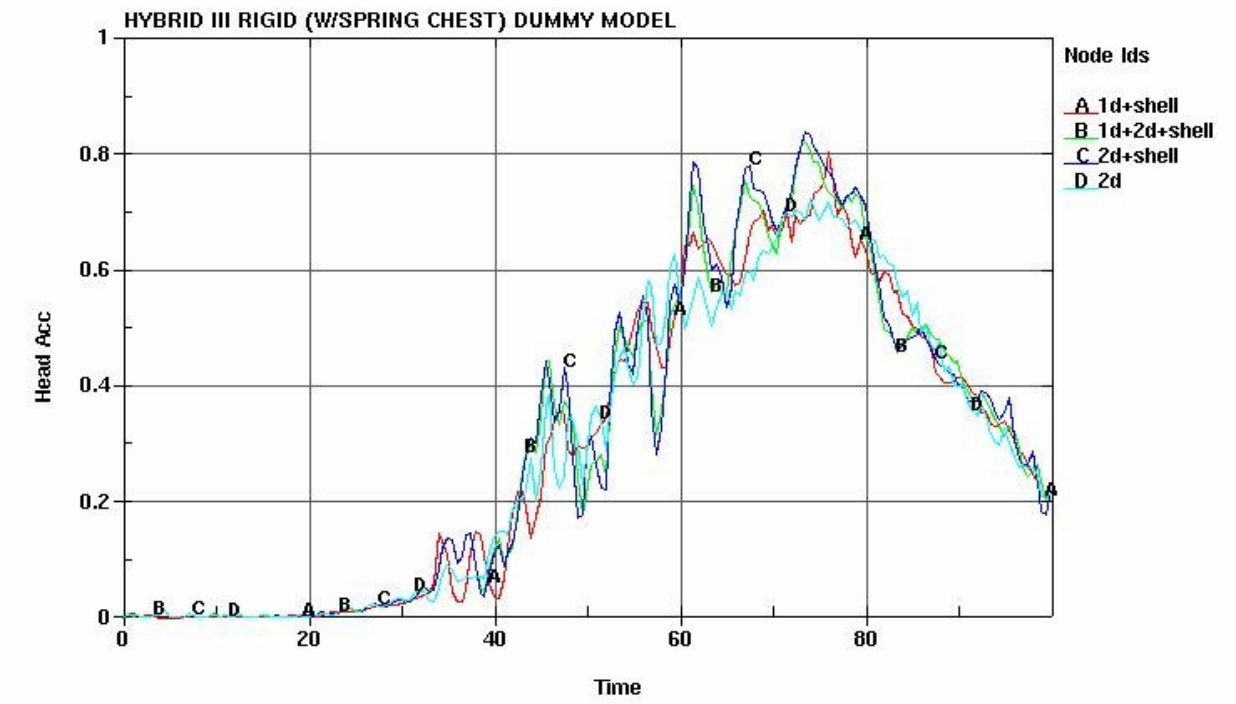


Fig. 5 Chest acc.

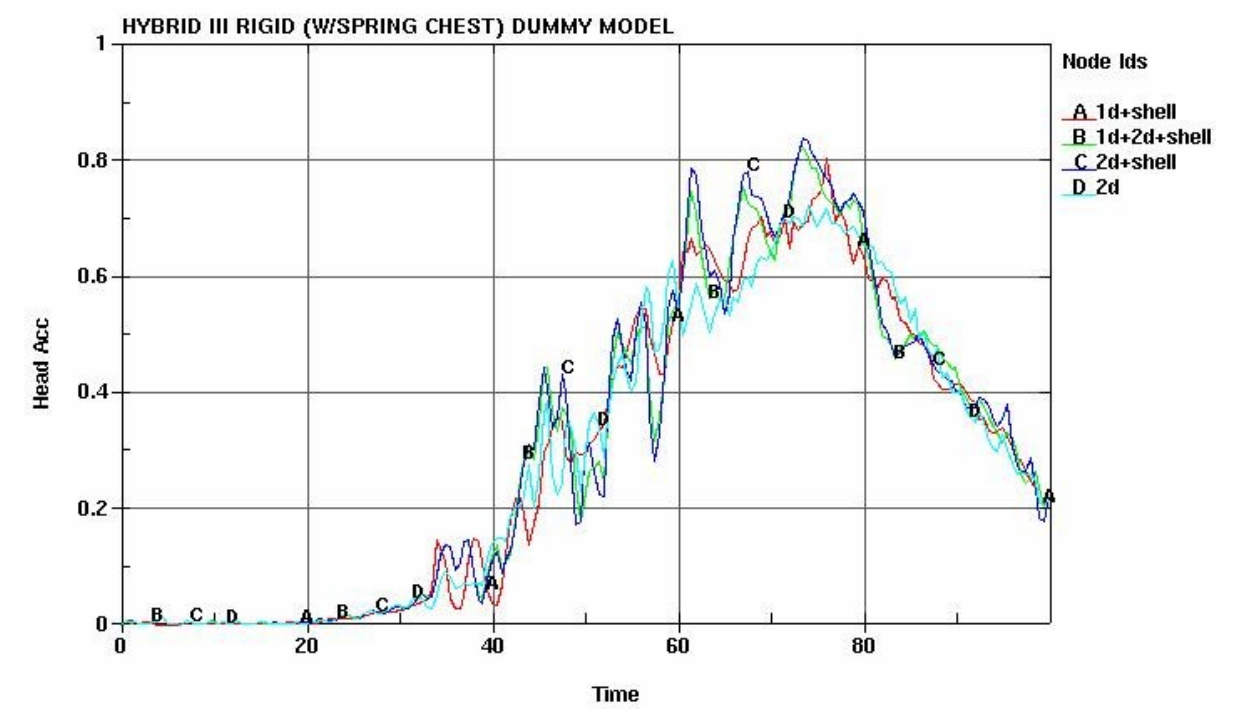


Fig. 6 Head acc.

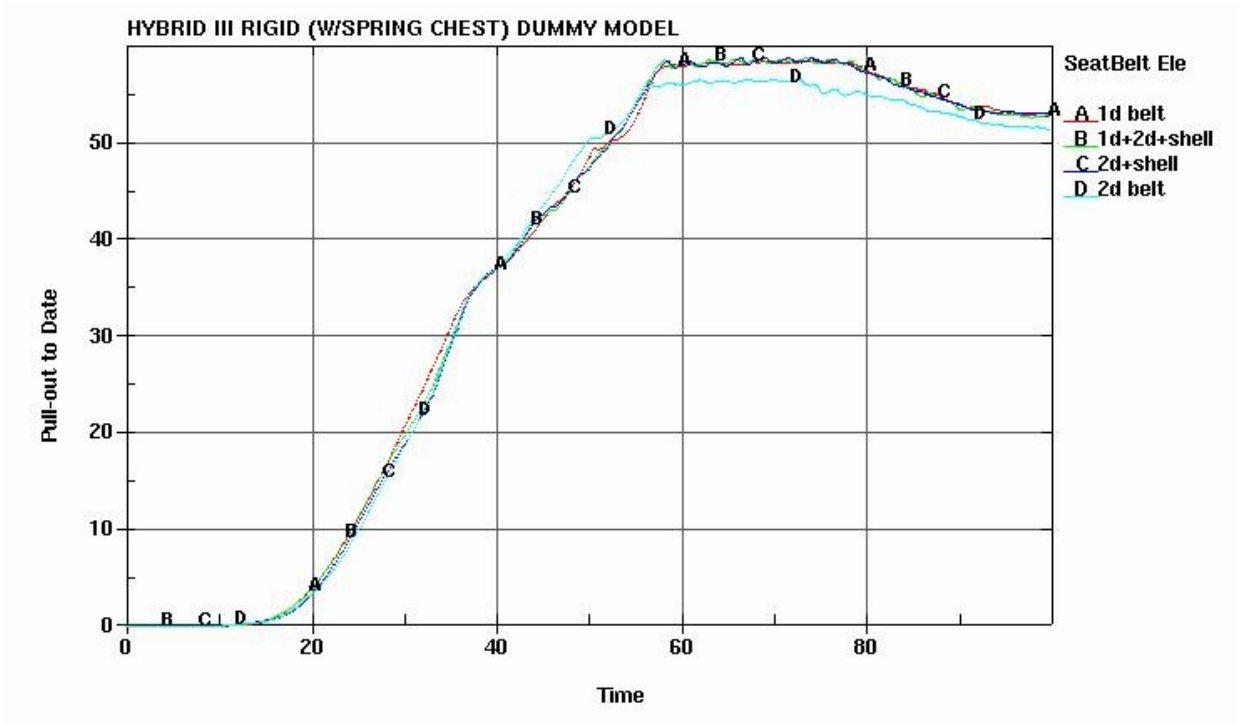


Fig. 7 Retractor payout

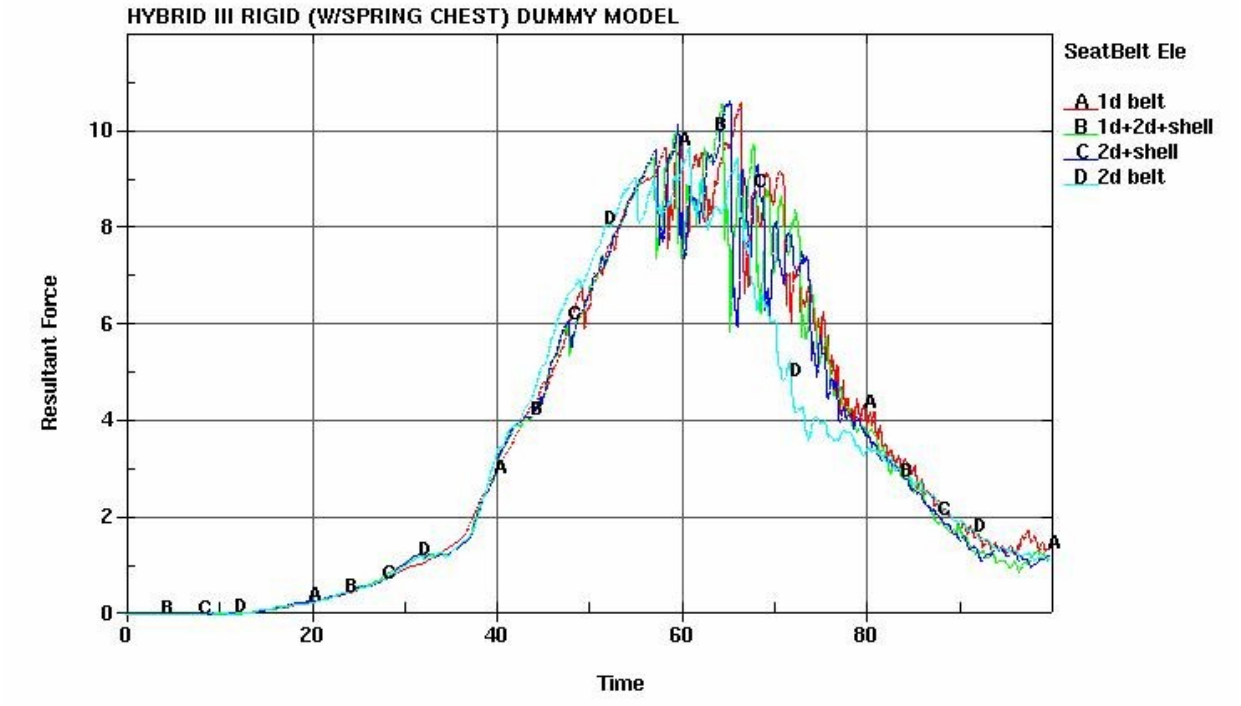


Fig. 8 Shoulder belt load

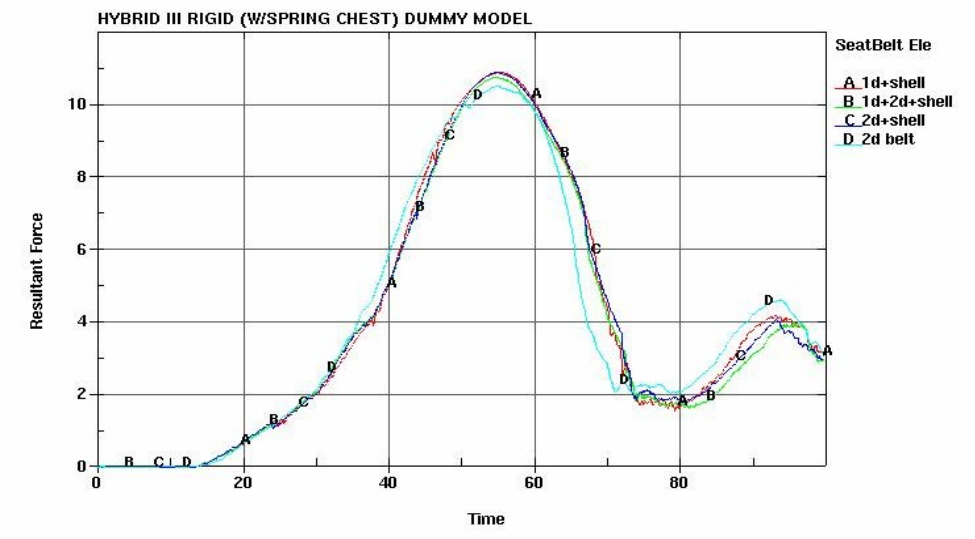


Fig. 9 Lap belt load

Sample files:

1. model of 2d belt, Fig.1, : ftp://ftp/lstc.com/outgoing/isheng/2d.k
2. model of traditional hybrid 1d belt, Fig. 2: ftp://ftp.lstc.com/outgoing/isheng/hybrid1d.k
3. model of hybrid 2d belts, Fig. 3, ftp://ftp.lstc.com/outgoing/isheng/hybrid2d.k
4. model of hybrid 1d&2d model, Fig.4, ftp://ftp.lstc.com/outgoing/isheng/hybrid1+2d.k

- **Summary of new input**

*MAT_SEATBELT

Variebla						CSE		
Type						F		
Default						none		

CSE EQ. 2: automatic control for compression elimination. Setting CSE to 2 also makes 2d belt results more comparable to 1d belt results, therefore is strongly recommended

*CONTROL_OUTPUT

Optional

	iprtf						ip1dblt	
type							I	
Default							0	

IP1DBLT EQ. 0: outputs of internally created 1d belts, retractors and sliprings are not available in SBTOUT any more. In stead, averaged 1d results are used to represent 2d results and will be included in SBTOUT.
EQ. 1: output of all internally created 1d belts, retractors and sliprings will be recovered. This option is not recommended.