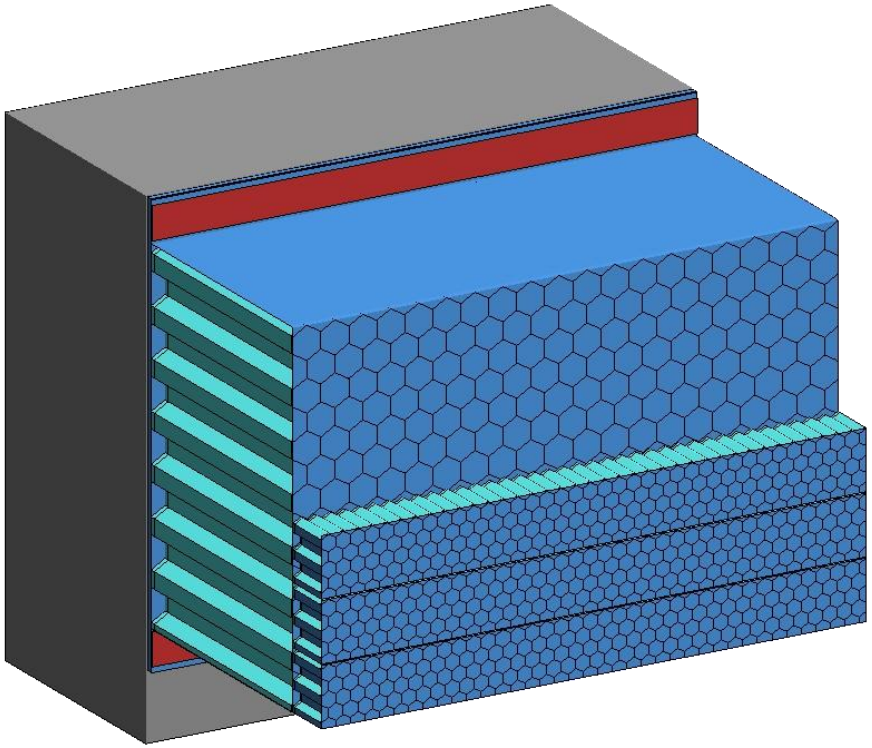
European (EEVC)
Offset Deformable Barrier (ODB)
Shell Element Model
Version 1.1



Development Report

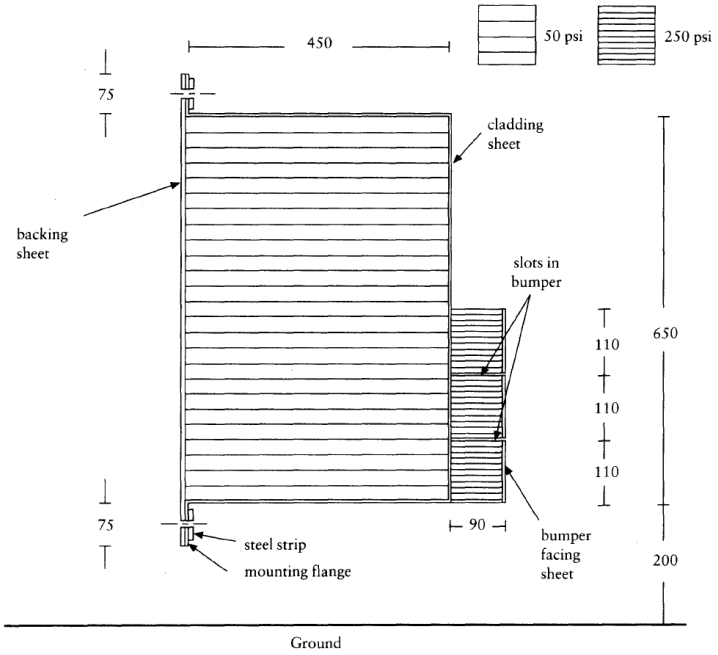
September 2010

General Information

The specification used for the deformable frontal impact barrier in this documentation has been taken ECE R94 Revision 1 - Frontal Impact Protection dated May 2007

Barrier Characteristics

- The impactor consists of two different sized aluminium honeycomb blocks partially covered in aluminium sheets
- The main aluminium block should be 1000 mm wide, 650 mm high and 450 mm deep.
- The second 'bumper' block should be 1000 mm wide, 330 mm high and 90 mm deep.
- The ground clearance should be 200 mm.



General Information

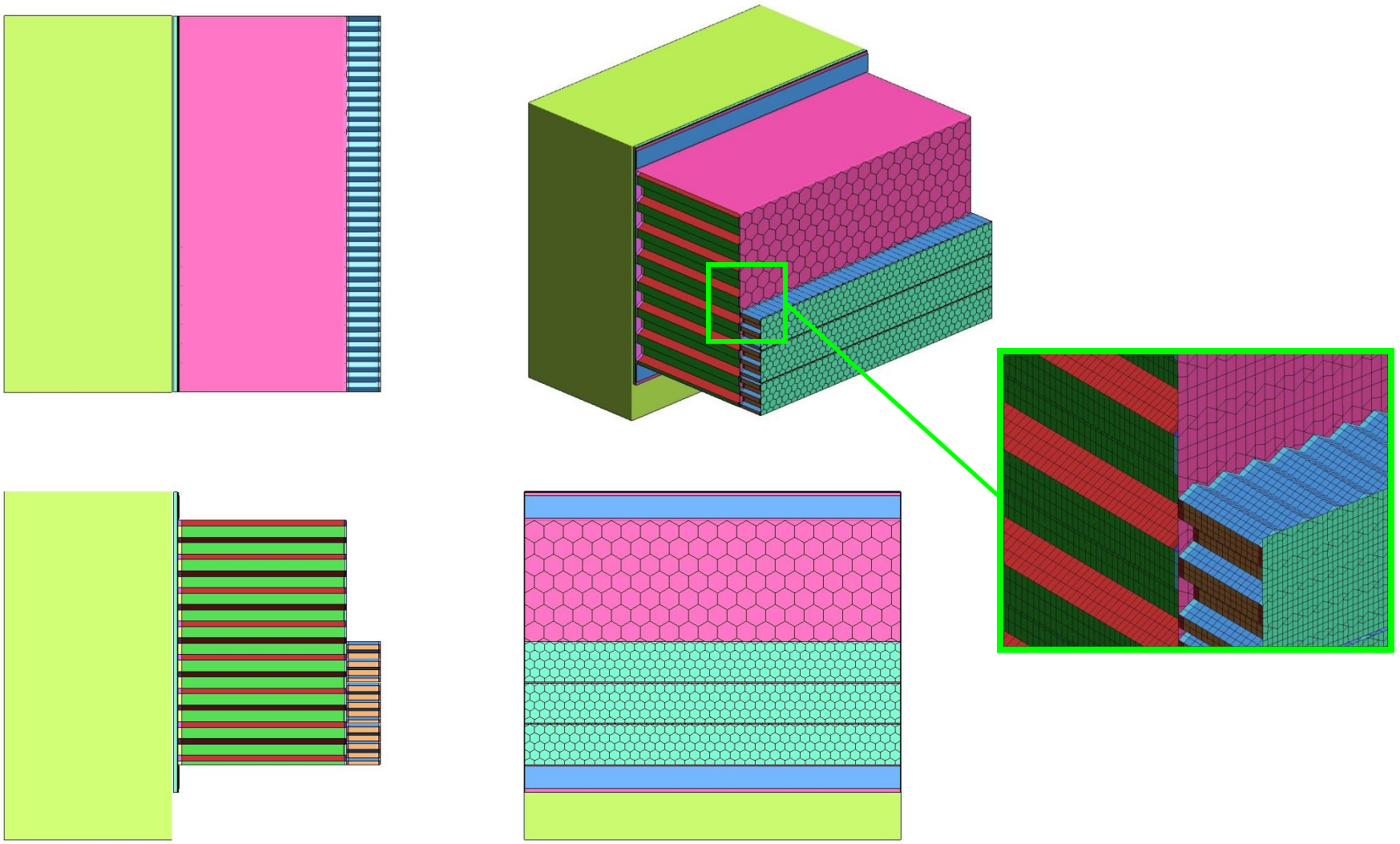
Material Characteristics

- The main honeycomb block should have a crush strength of 0.342 N/mm2 (50 psi) +0 -10%.
- The bumper honeycomb block should have a crush strength of 1.71 N/mm2 (250 psi) +0 -10%.

Calibration Procedure

- No calibration test is specified for the deformable frontal impact barrier as its crush performance is characterised by its material properties.

Figure 1.1 – ODB barrier model



Calibration Tests

The five test that have been selected for correlating the barrier are described below:

Test A – Rigid Wall Impact

This test involves a rigid wall impacting the barrier. The velocity is 8.2m/s. Figure 1.2 shows the test configuration. Figure 1.4 shows the force characteristic of the barrier obtained from the analysis compared with test. The curves have been normalized to unity.

Test B – Half Wall Impact

This test involves a half wall (50% overlap) impacting the barrier. The velocity is 8.6m/s. Figure 1.5 shows the test configuration. Figure 1.7 shows the force characteristic of the barrier obtained from the analysis compared with test. The curves have been normalized to unity.

Test C – Low Horizontal Bar Impact

This test involves a horizontal bar (50% overlap) impacting the bumper section of the barrier. The velocity is 8.4m/s. Figure 1.8 shows the test configuration. Figure 1.10 shows the force characteristic of the barrier obtained from the analysis compared with test. The curves have been normalized to unity.

Test D – High Horizontal Bar Impact

This test involves a horizontal bar (50% overlap) impacting the upper section of the barrier. The velocity is 6.5m/s. Figure 1.11 shows the test configuration. Figure 1.13 shows the force characteristic of the barrier obtained from the analysis compared with test. The curves have been normalized to unity.

Test E – Vertical Bar Impact

This test involves a vertical bar impacting the centreline of the barrier. The velocity is 8.3m/s. Figure 1.14 shows the test configuration. Figure 1.16 shows the force characteristic of the barrier obtained from the analysis compared with test. The curves have been normalized to unity.

Figure 1.2 – ODB Test A

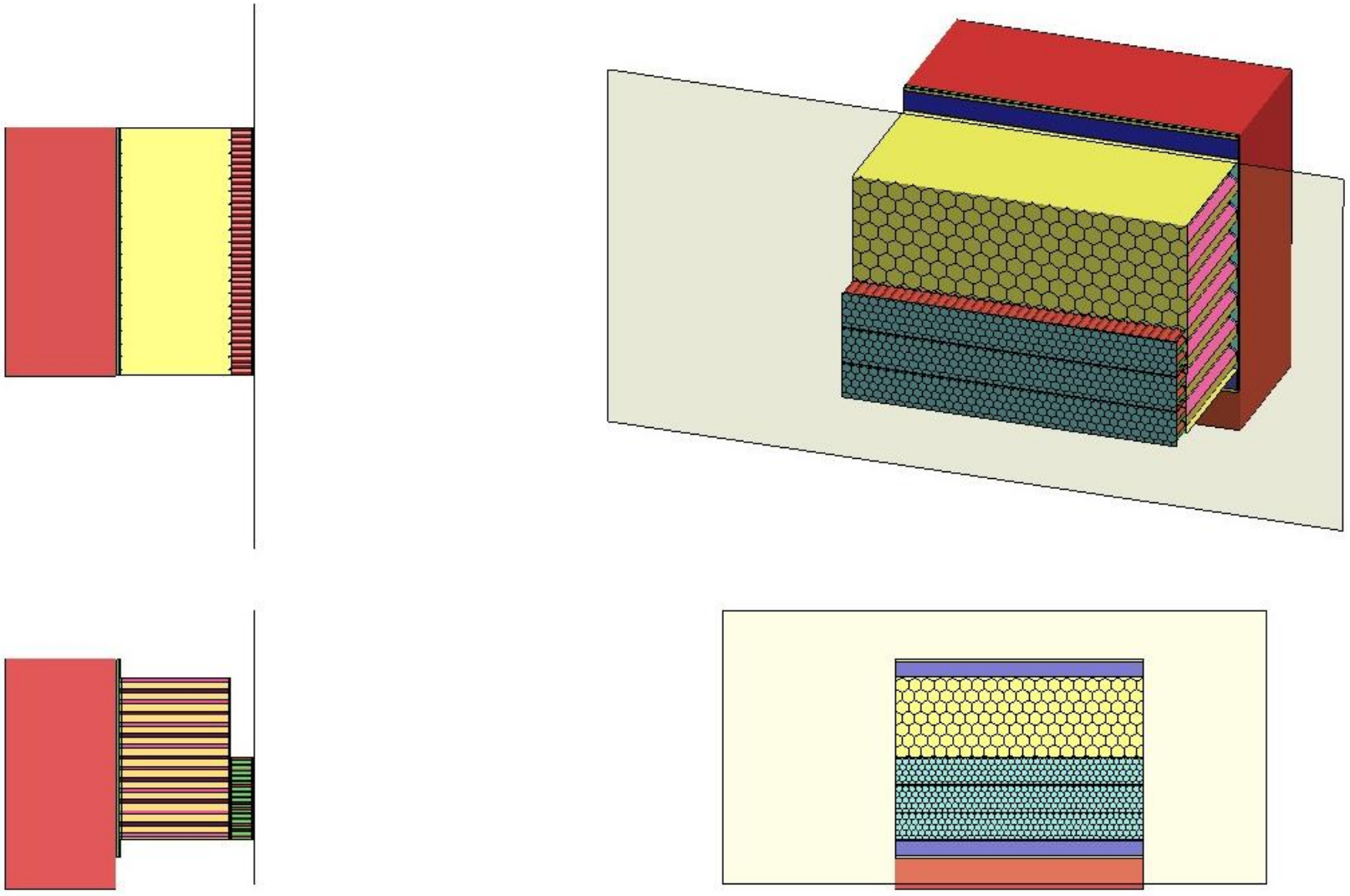


Figure 1.3 – ODB Test A final deformation

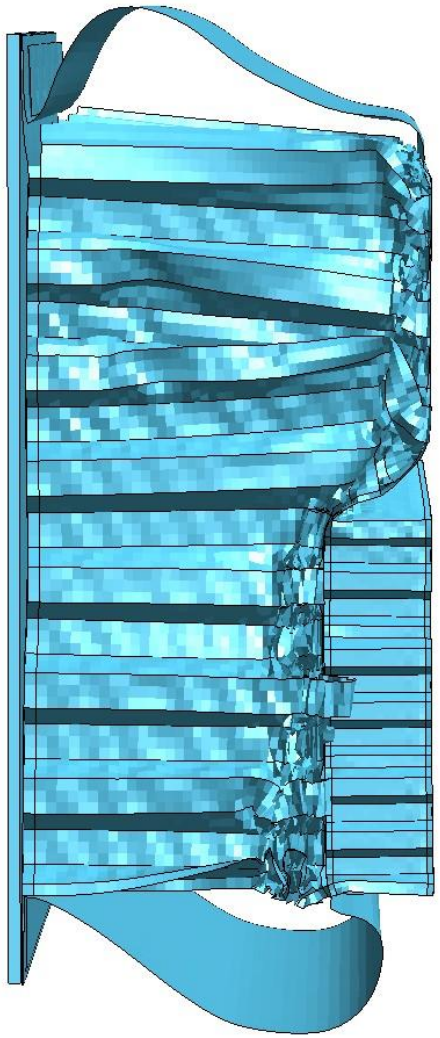


Figure 1.4 – ODB Test A Force – Deflection Curve (C60)

Figure 1.5 – ODB Test B

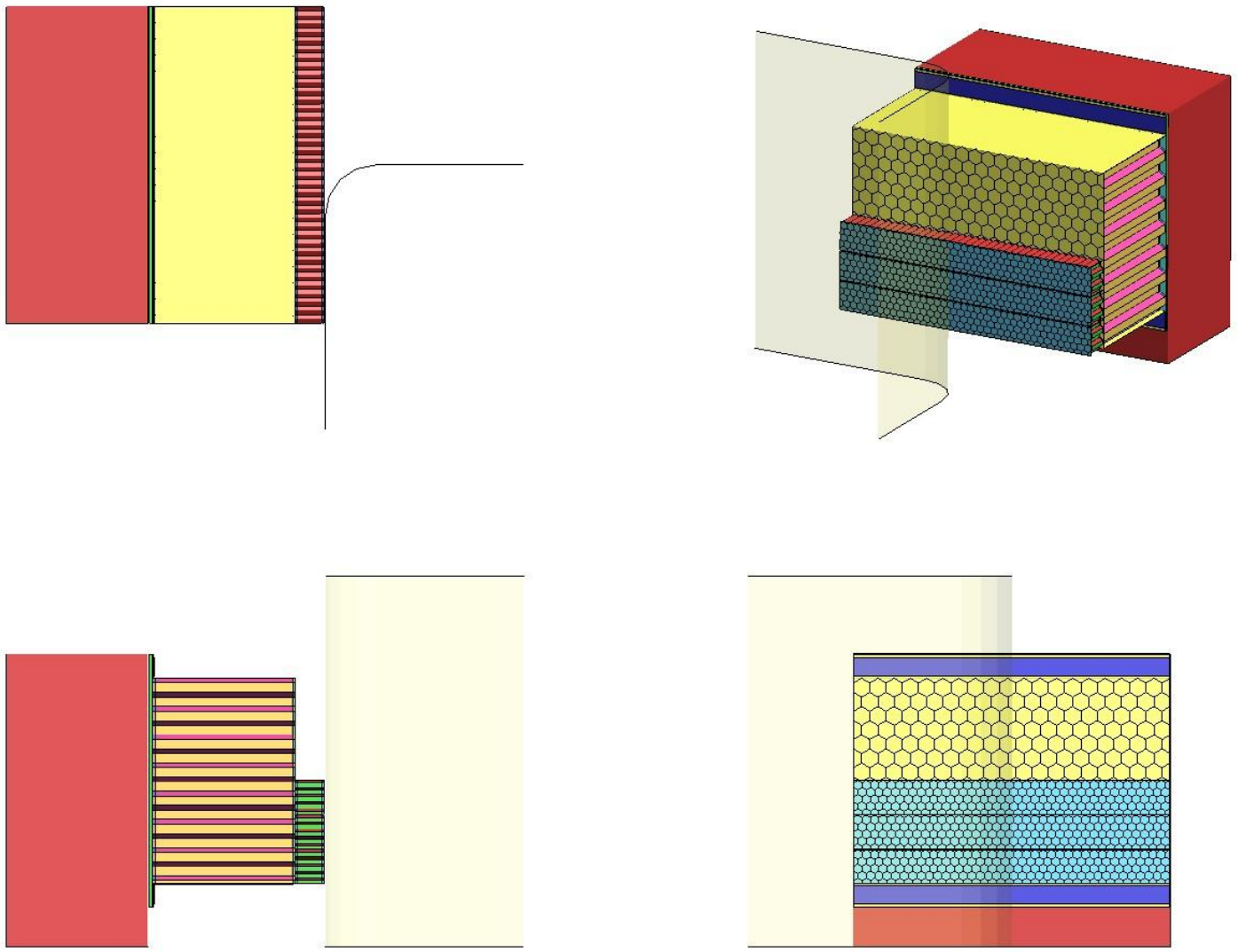


Figure 1.6 – ODB Test B final deformation

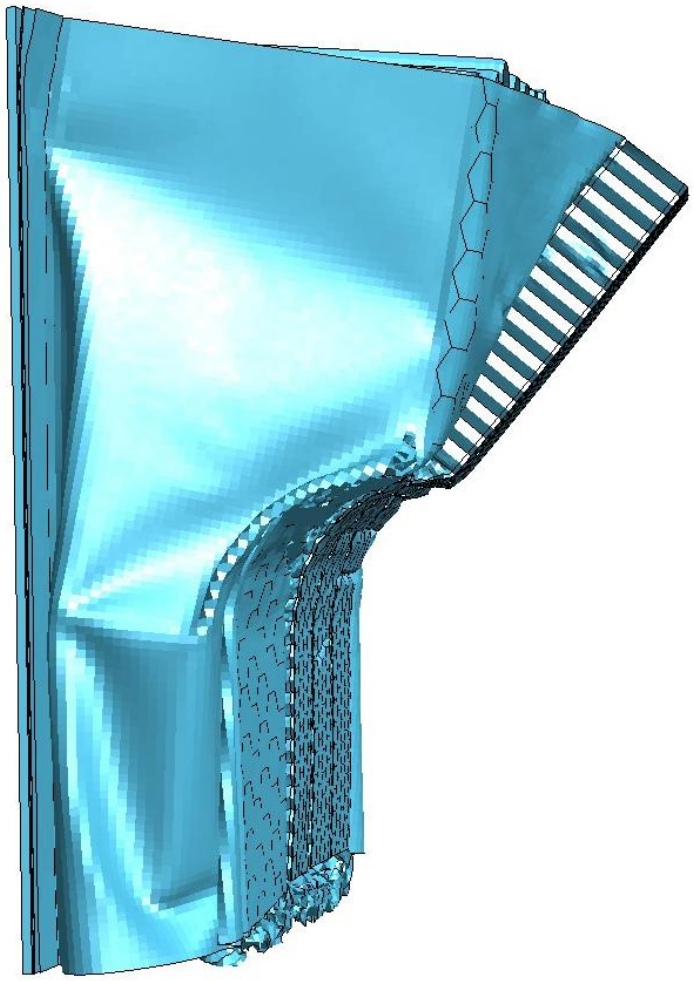


Figure 1.7 – ODB Test B Force – Deflection Curve (C60)

Figure 1.8 – ODB Test C

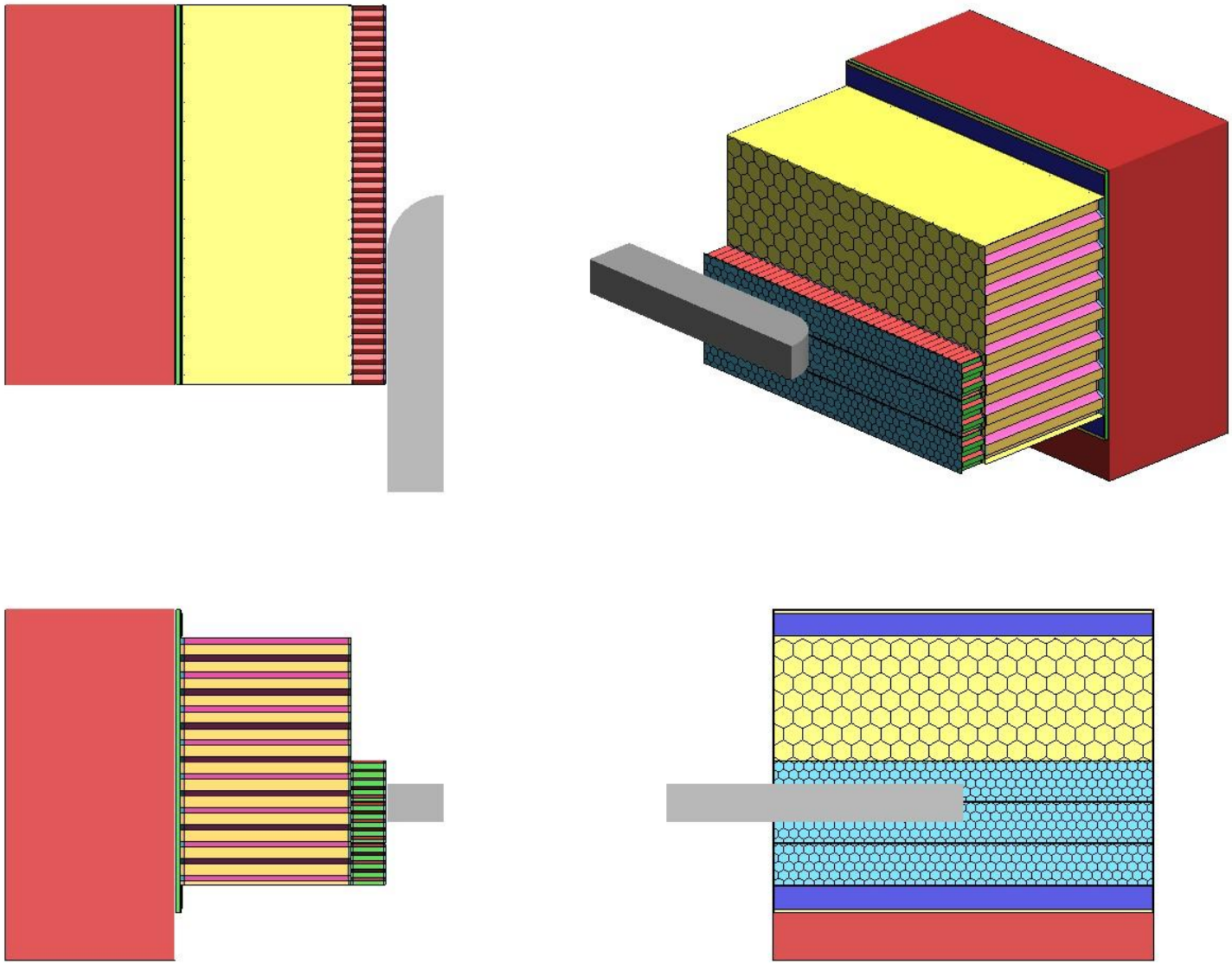


Figure 1.9 – ODB Test C final deformation

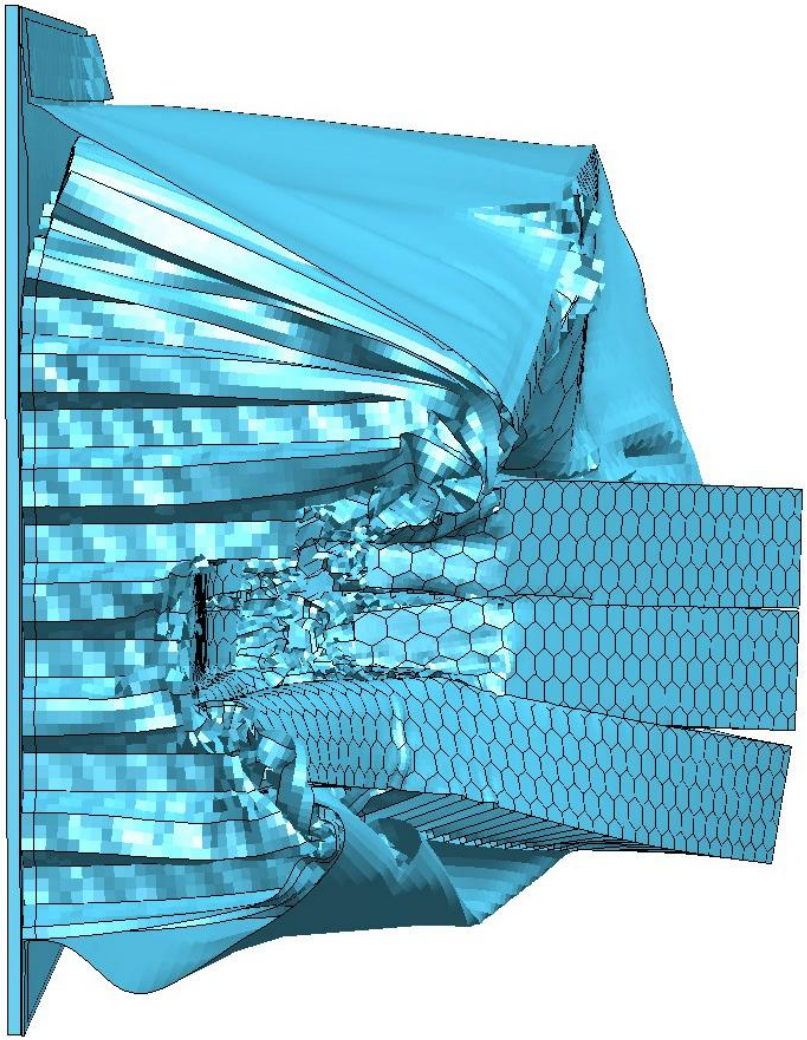


Figure 1.10 – ODB Test C Force – Deflection Curve (C60)

Figure 1.11 – ODB Test D

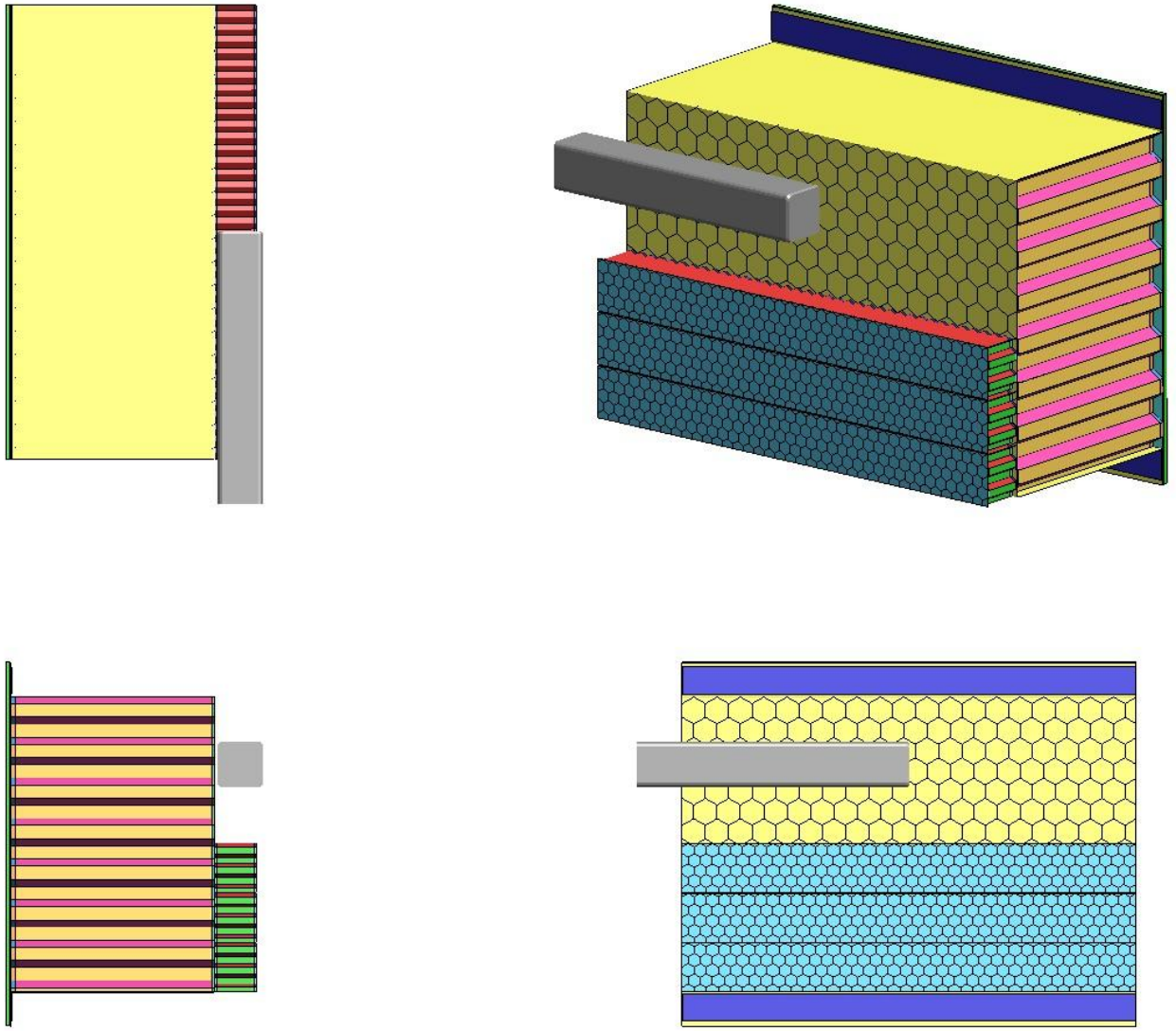


Figure 1.12 – ODB Test D final deformation

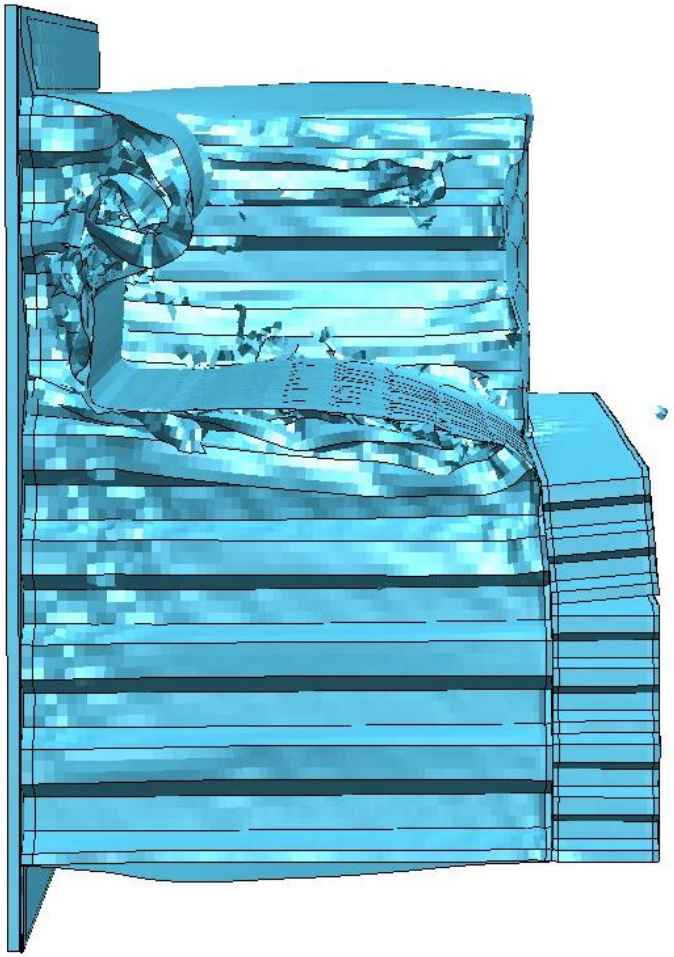


Figure 1.13 – ODB Test D Force – Deflection Curve (C60)

Figure 1.14 – ODB Test E

EEVC Offset Deformable Barrier Model

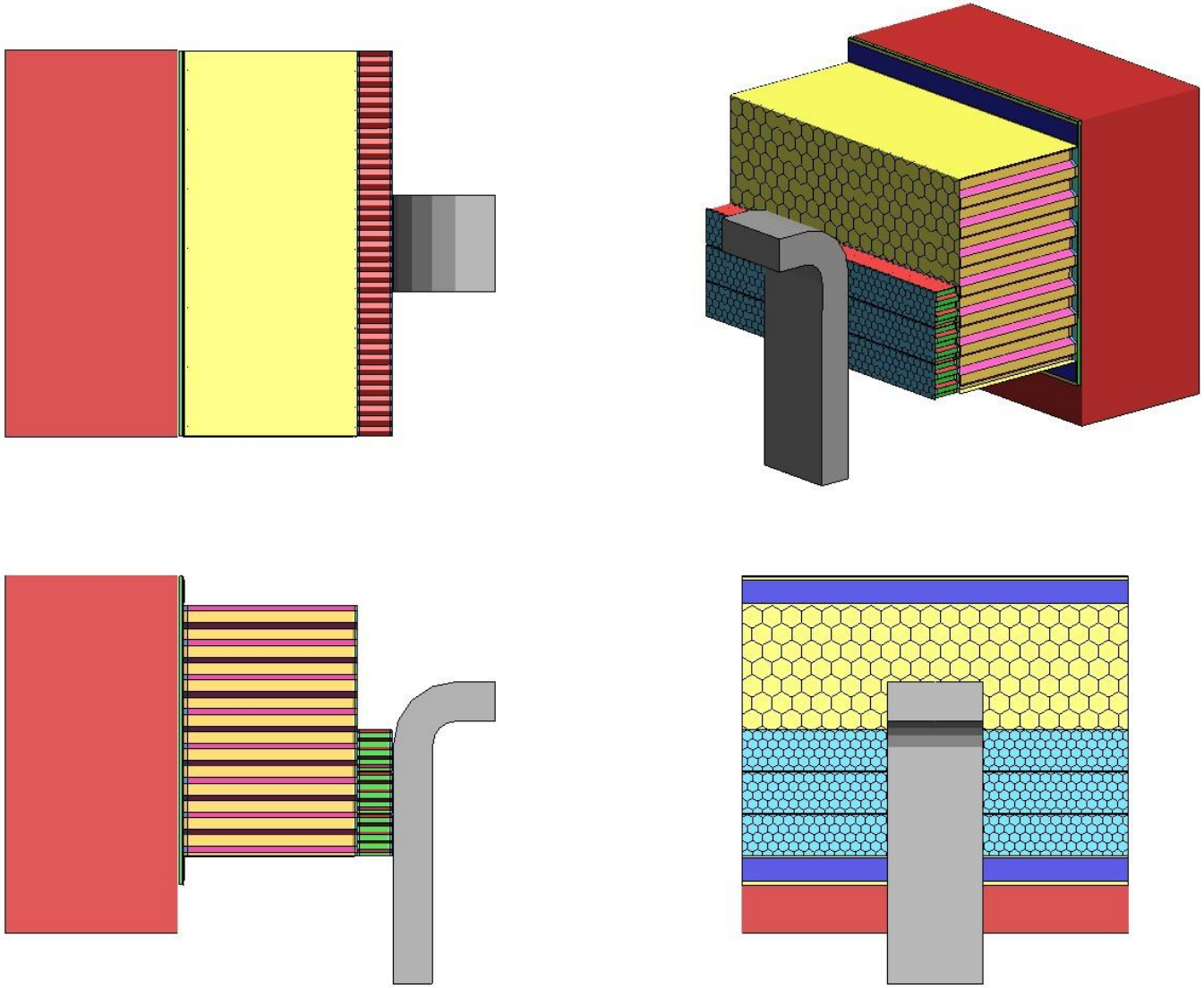
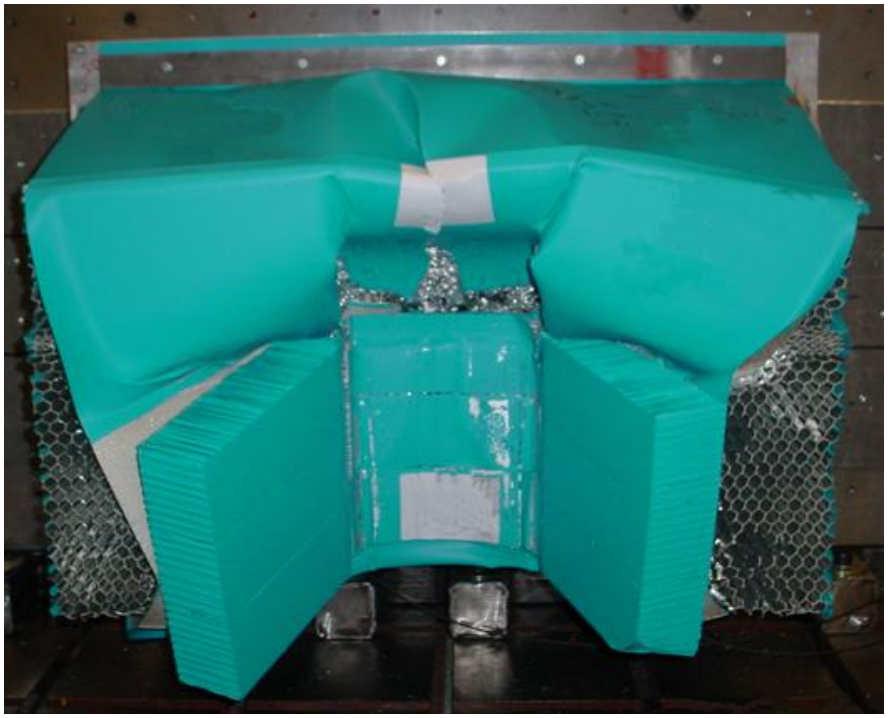


Figure 1.15 – ODB Test E final deformation



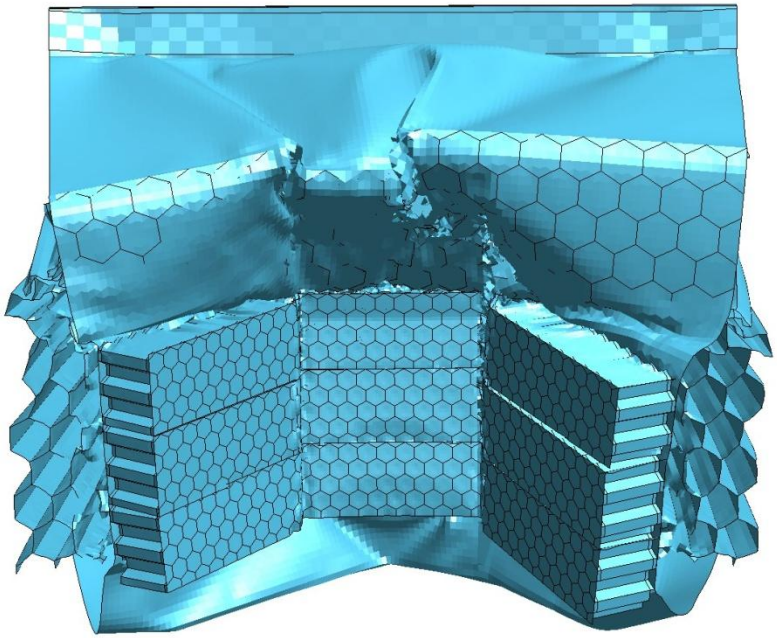
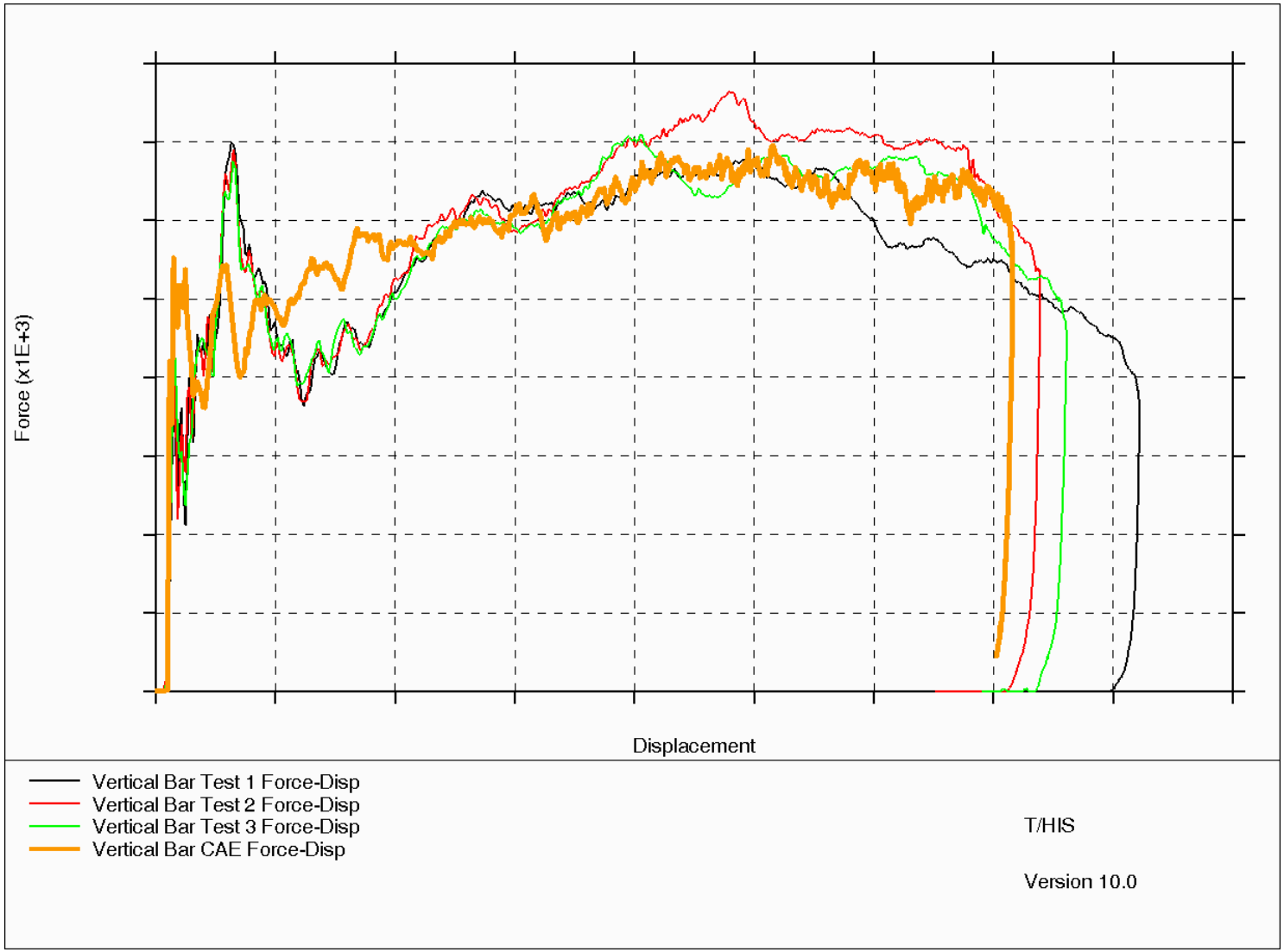


Figure 1.16 – ODB Test E Force – Deflection Curve (C60)



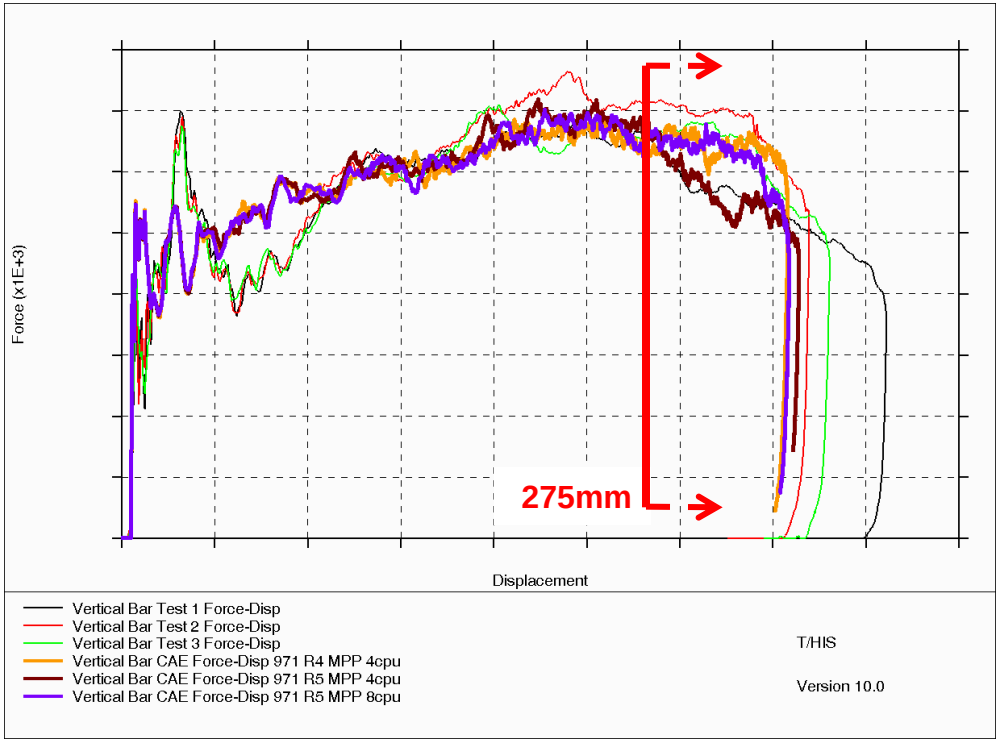
Model Sensitivty

The behaviour of the barrier is sensitive to where and how the main cladding starts to tear. This can be seen in the variation of the test results or the low horizontal bar and vertical bar load cases which have both show significant tearing in the cladding.

The CAE model of the barrier is also sensitive to where and how the main cladding starts to tear, and as such variations in the model setup, LS-DYNA version or analysis machine can result in a change in how the cladding tears and hence the behaviour of the model post failure.

Vertical Bar Example

The test case has been run in different versions of LS-DYNA and shows a variation in the result from the point (deflection = 275mm) where the cladding starts to tear.



Version Data

Model Version	Date	Modifications	Created by	Approved by
1.0	July 2010	New Model	I Bruce 	B Walker 
1.1	Sept 2010	Honeycomb orientation adjusted	I Bruce 	B Walker 

Company and Contact Information

The Offset Deformable Barrier model is developed by Arup in association with Cellbond Composites.

www.cellbond.com

www.arup.com

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