Application of Shell Honeycomb Model to IIHS MDB Model

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ABSTRACT:

This paper describes a new finite element modeling method of Aluminum honeycomb using shell elements. It is our new modeling method that cell size of honeycomb structure is enlarged to increase time step size for FEM analysis, and compressive strength is controlled by thickness of shell elements.

New modeling method was applied to IIHS moving deformable barrier model, and side impact analysis with a full vehicle model was performed. The result of simulation using a new barrier model showed much better correlation with a test result than previous simulations.

Keywords:

Automotive Crashworthiness, Side Impact, Moving Deformable Barrier (MDB), and Aluminum Honeycomb

Development of IIHS Side Impact MDB Model using Shell Elements

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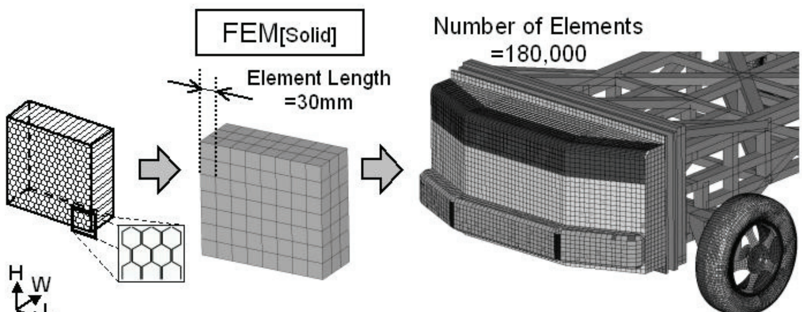
1. Motivation of Study #1

- Side impact simulations using MDB model with a **SOLID** Aluminum honeycomb model were performed. (~2005)



IIHS Side Impact MDB Model [Solid]

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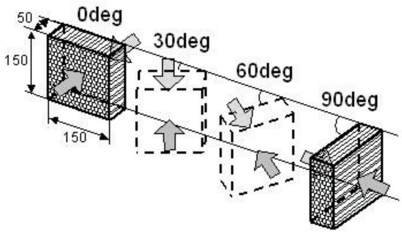
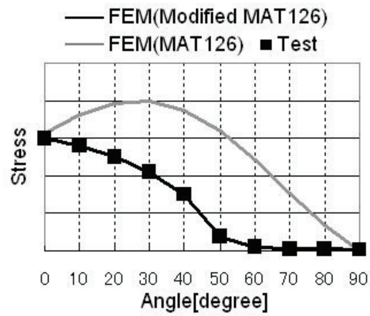
1. Motivation of Study #2

- Modified MAT126 can simulate direction dependency of real honeycomb compressive strength.



Honeycomb Compression test



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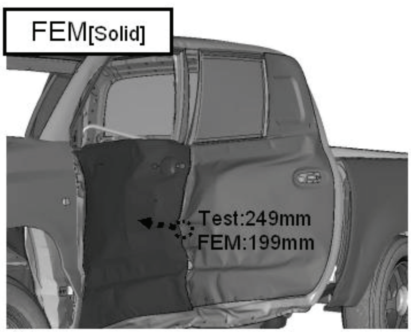
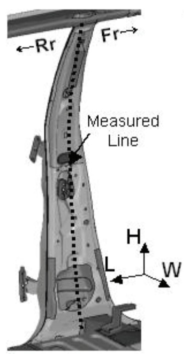
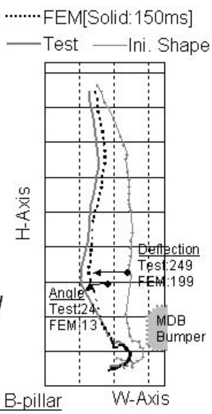
1. Motivation of Study #3

- Deflection and deformed angle of FE B-pillar was smaller than the test.





Deformed Shape of B-pillar



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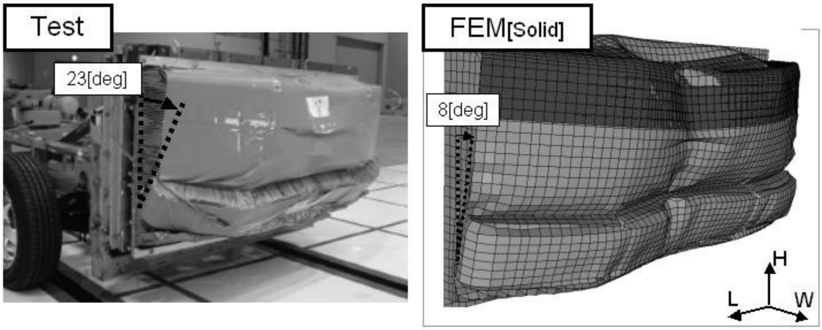
1. Motivation of Study #4

- Deformed angle of FE bumper honeycomb was smaller than the test.



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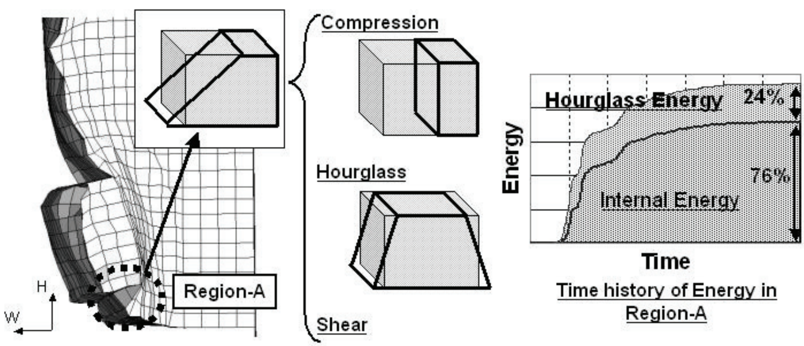
1. Motivation of Study #5

- Excessive strength that was caused by hourglass control might prevent the bumper honeycomb rotation.



Time history of Energy in Region-A

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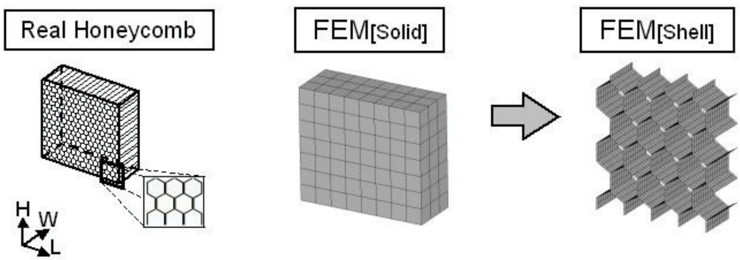
1. Motivation of Study #6

- Shell elements was applied to a honeycomb model to reduce excessive strength that was caused by hourglass control for solid elements.



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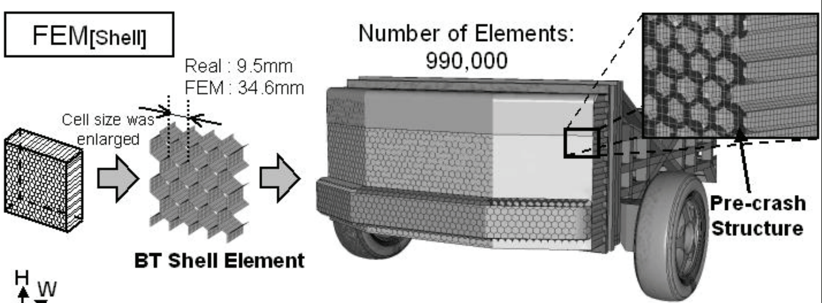
2. Shell Honeycomb Model #1

- Cell size of honeycomb model is enlarged to reduce the number of elements.
- Fr side edge of honeycomb shell elements are pre-crashed.



IIHS Side Impact MDB Model [Shell]

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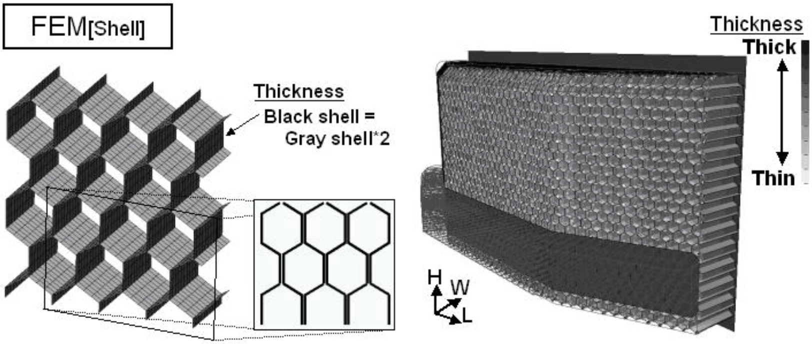
2. Shell Honeycomb Model #2

- Black shell thickness is double size of gray element.
- Compressive strength is controlled by shell thickness.

FEM[Shell]



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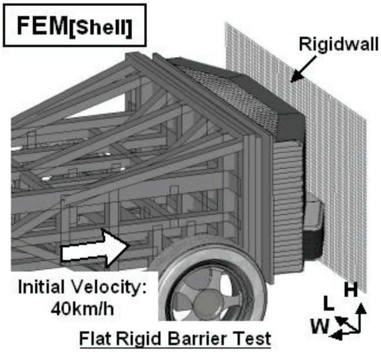
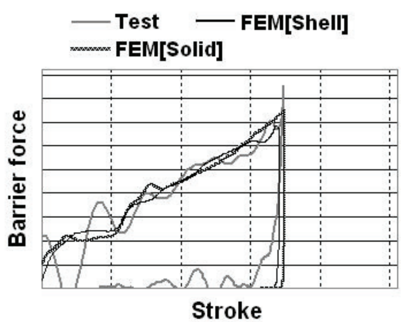
3. Result (Rigid Barrier Test) #1

- Two rigid barrier test and FE analyses were performed.
- Both FE results are similar to the test.

FEM[Shell]





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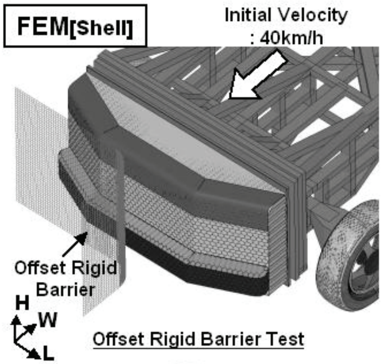
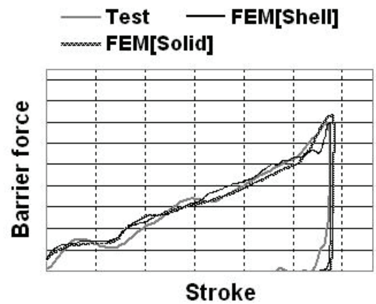
3. Result (Rigid Barrier Test) #2

- Both FE results are similar to the test.
- Shell honeycomb model can simulate compressive strength of IIHS side impact barrier.





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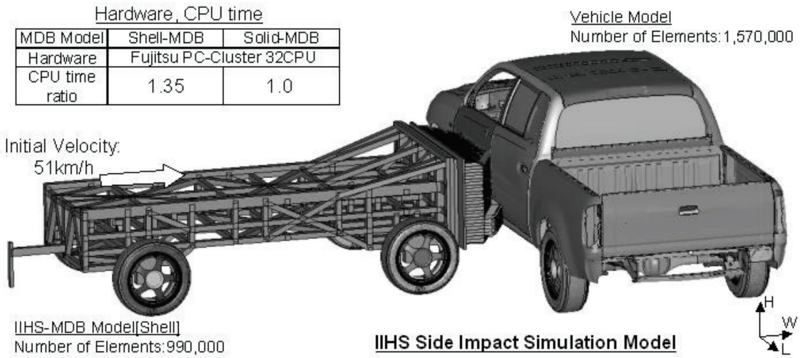
4. Result (Full Vehicle Side Impact) #1

- Full vehicle side impact collision analysis was performed.
- A simulation with shell MDB model requires 135% CPU time of solid MDB.

Hardware, CPU time

MDB Model	Shell-MDB	Solid-MDB
Hardware	Fujitsu PC-Cluster 32CPU	
CPU time ratio	1.35	1.0



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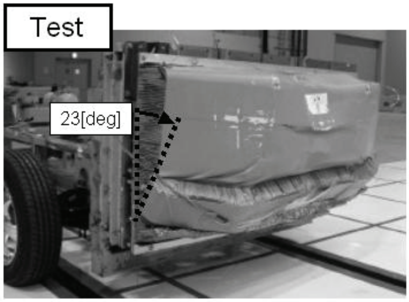
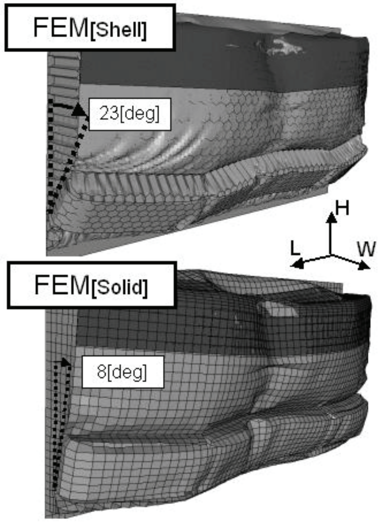
4. Result (Full Vehicle Side Impact) #2

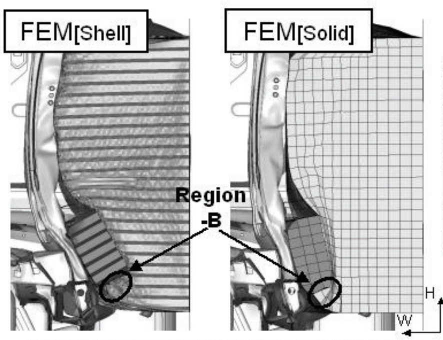
- Shell honeycomb model shows coincident deformed shape with the test.



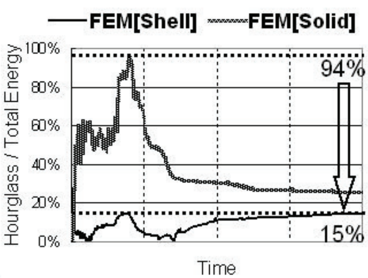


4. Result (Full Vehicle Side Impact) #3

- Shell MDB model reduces the ratio hourglass energy to total energy.
- Excessive strength that prevented bumper honeycomb rotation has been reduced.



Deformed shape of Aluminum Honeycomb[t=30ms]



Time history of energy ratio[HG/Total] in Region-B

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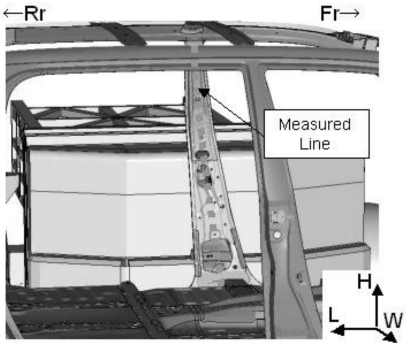
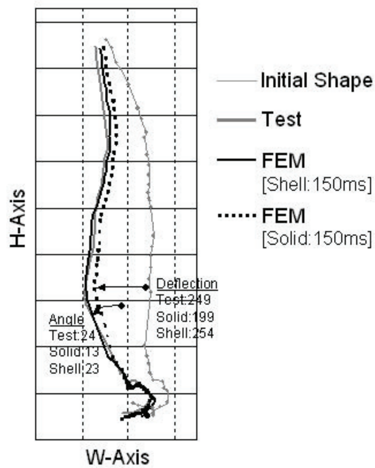
4. Result (Full Vehicle Side Impact) #4

- Shell MDB model shows coincident curved shape of B-pillar with the test.





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5. Conclusion

- An Aluminum honeycomb model was applied to IIHS side impact MDB model.
- Shell honeycomb model can simulate compressive strength of IIHS side impact MDB.
- Shell barrier model shows better correlation of vehicle B-pillar deformation than solid barrier model in a side impact collision analysis.

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