

GMT Bumper Beam

2008 SPE Conference

Agenda

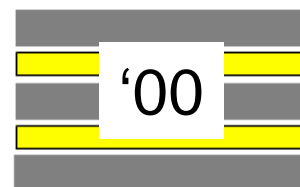
- **What is GMT ?**
- **Manufacturing Practices**
- **Applications/Benefits**
- **Bumper trend**
- **Hanwha capability**

1. GMT History

High Performance Thermoplastic Composites for *Bumper* Applications –

AZDEL

- (early 1970's) continuous fiber GMT – GM Beam
- (early 1990's)
 - UD+ Continuous RD
 - Honda Beam
- (late 1990's)
 - “Chopped” Long Fiber
 - Nissan, Mitsubishi Beam
- (New) IXIS – Hybrid Materials

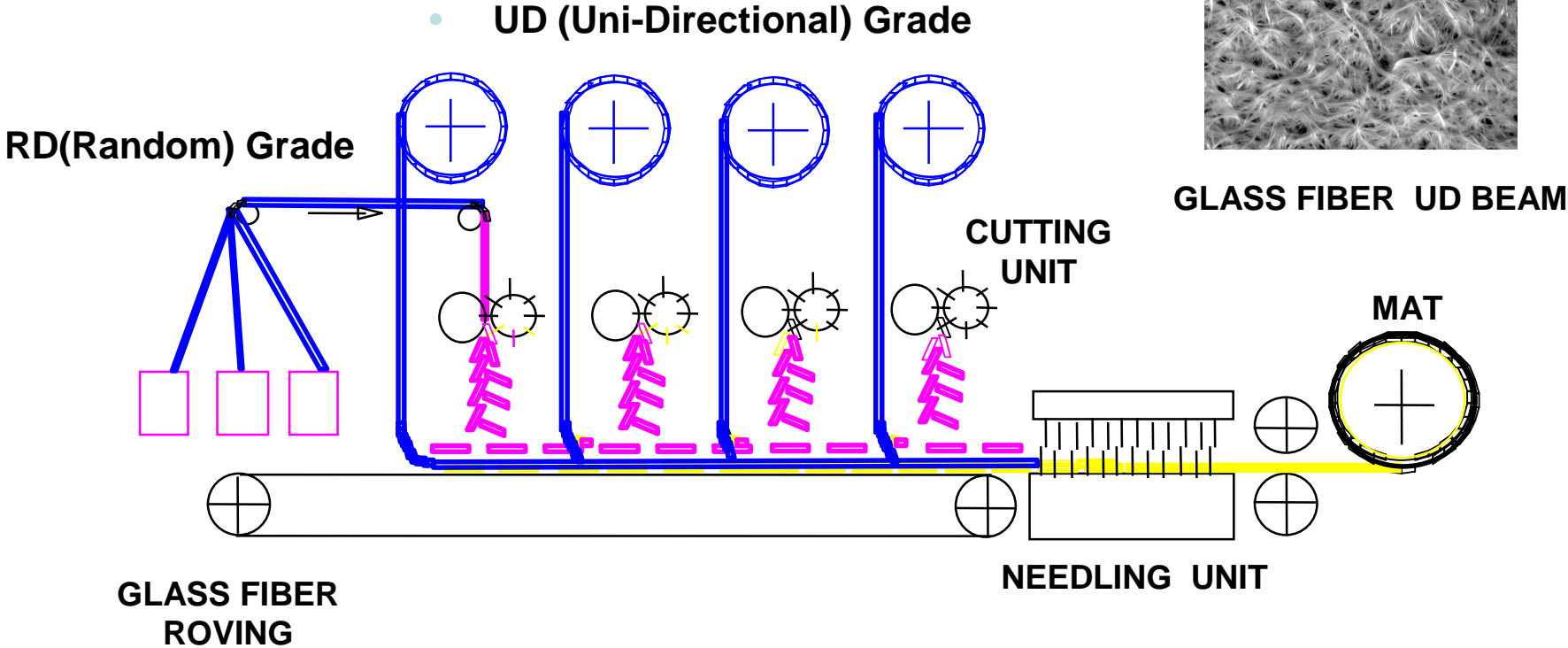
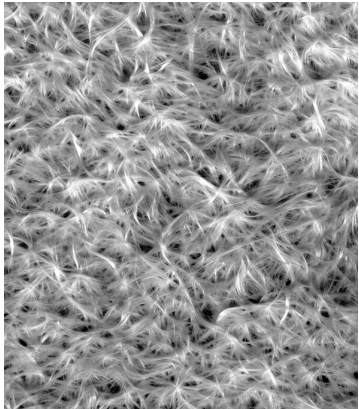


HANWHA

- (early 1980's)
 - Chop fiber GMT RD by Basf
 - VW, Peugeot FEM Carrier etc.
- (early 1990's)
 - Chop fiber GMT RD by QPC
 - VW, Peugeot Seat etc.
- (late 1990's)
 - UD Bumper by Hanwha
 - HMC, KIA, GMDW, SGM, etc
- (New) HIMT – GMT UD + TEX

HANWHA **New** GMT G/F Mat Production Process

- **Unique Glass-Mat Manufacturing Technology**
- **Important Process for GMT Manufacturing**



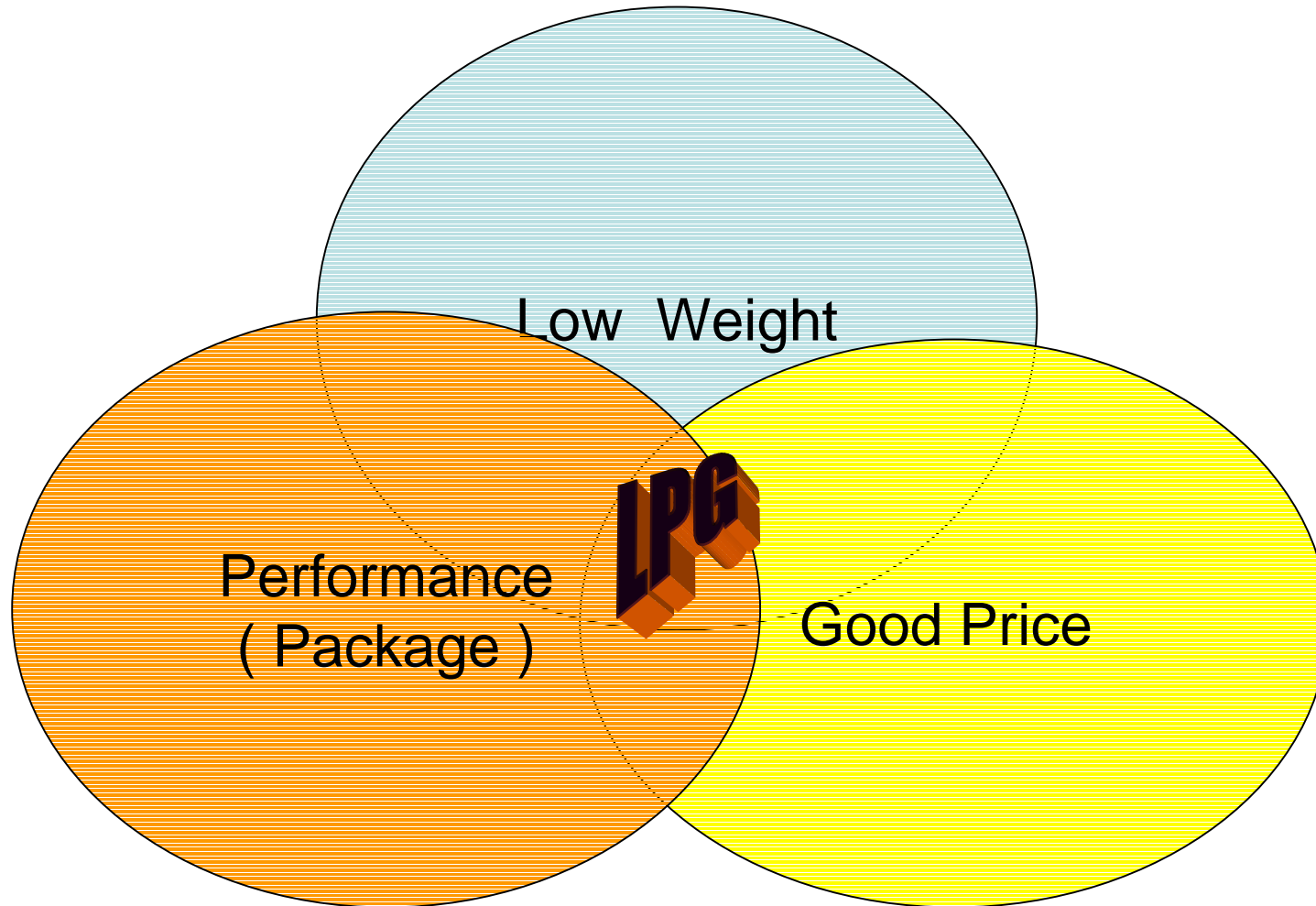
2. GMT Specification & Bumper

OEM	Grade	Material Maker	Bumper
GM NA	R401, C401 R 301, C321 C467	AZDEL	Focus on FMVSS,IIHS -RD beam :R401 -Chop(I) beam : C467,C507 -UD+ Continuous RD Merit : Low weight, Design flexibility
GME	R 301 (1988)	AZDEL	
NISSAN/ HONDA/ TOYOTA	C507/UD421	AZDEL	
GM Korea	UD45 / RD40	HANWHA	Focus on CMVSS, IIHS UD-Beam (High performance, Low damage)
GM China	UD45 / RD40	HANWHA	
GM Holden	U421 / R321	AZDEL	
HMC	UD45 / RD40	HANWHA	

❖ Hanwha GMT Back Beam

Global Market	Product	Major Proto	Molder
Korea	60% Domestic / 90% Export RR Beam	60% Domestic / 90% Export RR Beam	HANWHA, AIA
China	* 70 % HMC/KIA * Shanghai GM FRT/RR : Major Vehicle	* HMC/KIA 2 Major Vehicle * Shanghai GM SGM FRT : 1 ITEM SGM RR : 2 ITEM * Local OEM : 2 ITEM	HANWHA - Beijing Shanghai
India		1 Major Vehicle	HANWHA
EC	100% KMC RR Beam	3 Major vehicle	HANWHA- CZEC ('09)
NA	100% HMC RR Beam	3 Major Vehicle	HANWHA - Alabama

3. Bumper Beam Issue



1. New IIHS



part on the Mazda 6.
Styling influences of the styling can talk change that occurred AURA, G6, and 1 cars built on similar cars then I end : but the the at : I a c as c On top had to best of this topped

Good bumper performance requires not only engagement with the test barrier but also strength sufficient to absorb the energy of a low-speed crash. Hyundai engineers strengthened the Sonata's bumper after learning about the Institute's upcoming series of new tests.



STATUS

NEW
R

❖ IHS Test Result

Bumper performance in low-speed crash tests: VEHICLE REPAIR COSTS					
	Front full	Front corner	Rear full	Rear corner	TOTAL DAMAGE
Mitsubishi Galant	\$929	\$1,138	\$1,048	\$1,162	\$4,277
Toyota Camry	\$936	\$1,467	\$1,480	\$1,028	\$4,911
Mazda 6	\$978	\$1,384	\$1,202	\$1,397	\$4,961
Ford Fusion	\$1,620	\$991	\$1,298	\$1,121	\$5,030
Volvo S40	\$2,252	\$1,306	\$802	\$1,240	\$5,600
Kia Optima	\$1,730	\$1,534	\$1,715	\$756	\$5,735
Saturn AURA	\$1,032	\$1,152	\$3,191	\$999	\$6,374
Nissan Altima	\$945	\$969	\$3,114	\$1,431	\$6,459
Chevrolet Malibu	\$1,268	\$1,610	\$2,542	\$1,226	\$6,646
Subaru Legacy	\$3,911	\$1,287	\$1,122	\$1,128	\$7,448
Chrysler Sebring	\$1,084	\$2,061	\$3,210	\$1,099	\$7,454
Hyundai Sonata	\$4,312	\$1,349	\$739	\$1,165	\$7,565
Honda Accord	\$3,469	\$1,169	\$2,767	\$605	\$8,010
Volkswagen Passat	\$4,594	\$1,544	\$982	\$1,139	\$8,259
Pontiac G6	\$4,588	\$1,183	\$1,638	\$1,510	\$8,919
Volkswagen Jetta	\$2,598	\$1,223	\$3,375	\$1,824	\$9,020
Nissan Maxima	\$4,535	\$1,732	\$1,787	\$997	\$9,051



SONATA



SEPHIA



ELANTRA

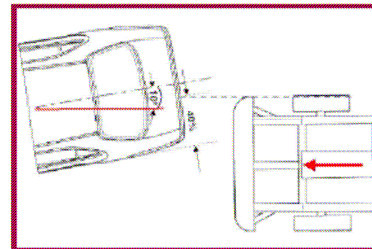
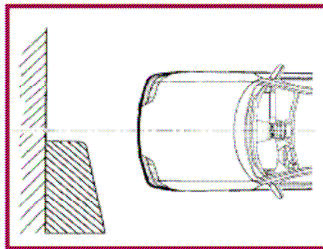
GMT bumper Result

2. RCAR

- Index rating
- RCA standardization

RCAR- Front-crash

- impact against rigid wall (10°)
- v = 15 km/h
- offset 40%



RCAR-Rear-crash

- impact (10°) with moving barrier
- v = 15 km/h
- offset 40%
- m = 1400 kg

Front damage:

- labour costs: mechanics, body, paintings
- parts costs: spare parts, paint material

Side damage:

- replacement of drivers door
- partial replace of door sill
- labour and parts costs

Rear damage:

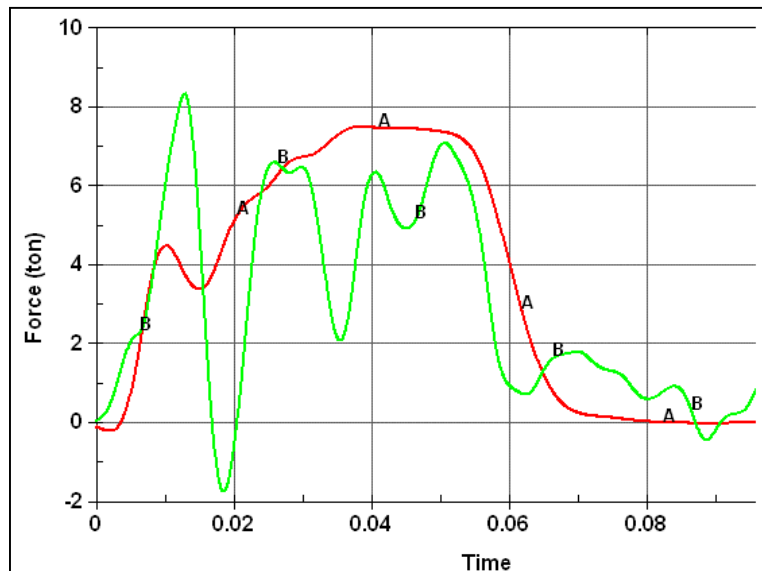
- labour costs: mechanics, body, paintings
- parts costs: spare parts, paint material

$$\text{Total repair costs: } C_{TR} = 0,54 * C_{FD} + 0,16 * C_{SD} + 0,30 * C_{RD}$$

*

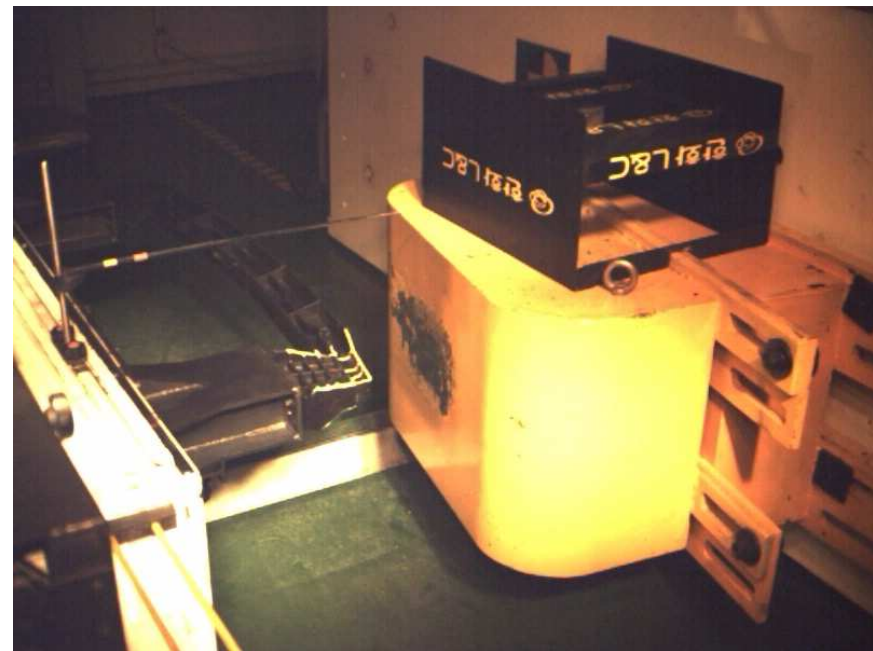
■ I Section RR Beam

RR BEAM		Total I.E	Max. Force	Max. Intrusion
Requirement		> 5.0kJ	< 8.0 ton	-
Proto - type	FEA	4.8 kJ	7.8 ton	132.5 mm
	Test	4.2kJ	8.1 ton	116.2 mm

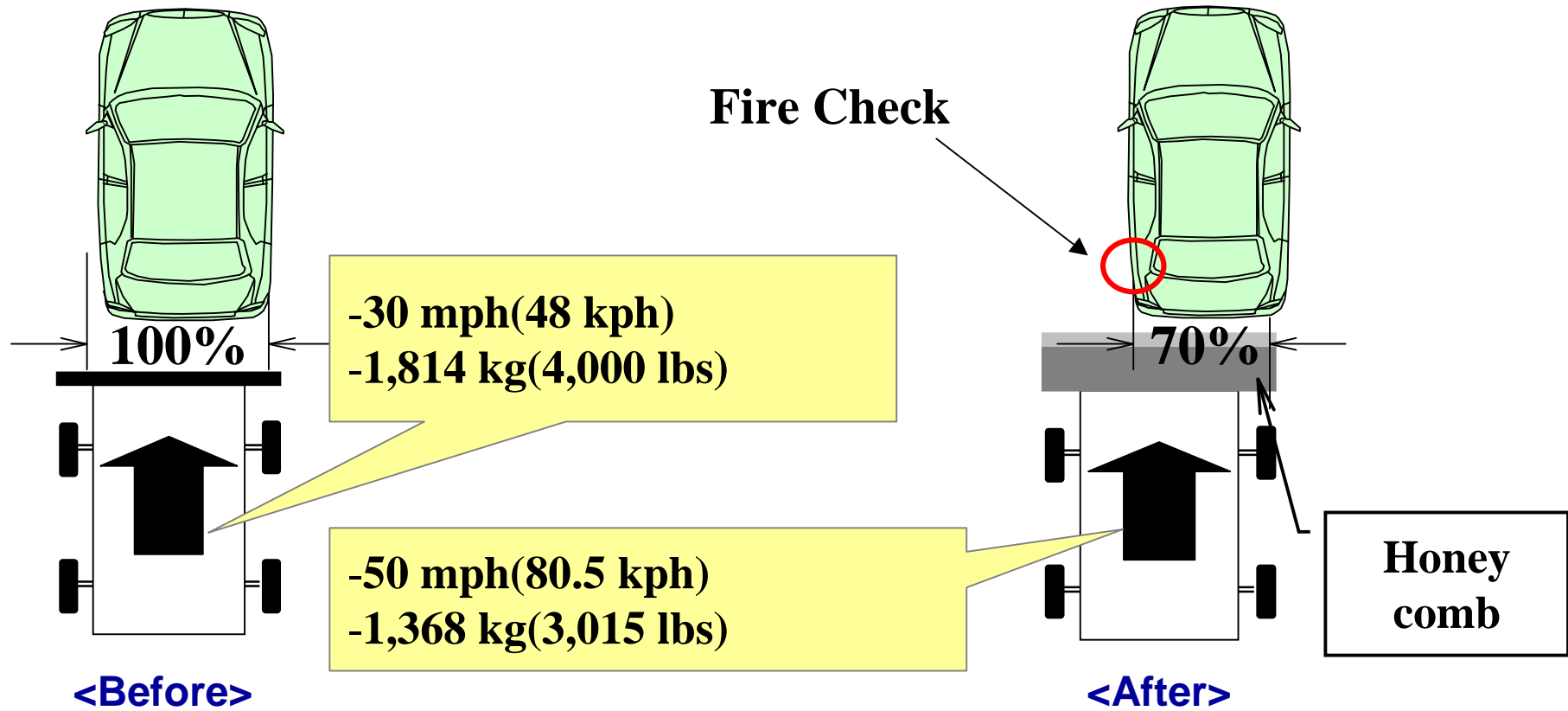


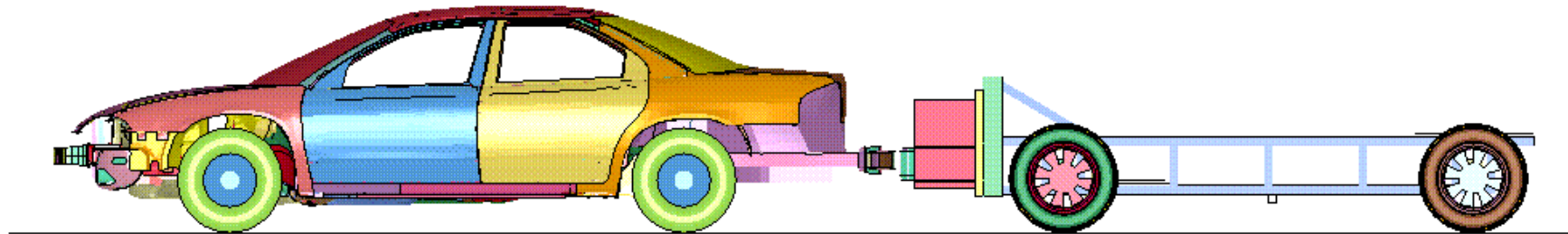
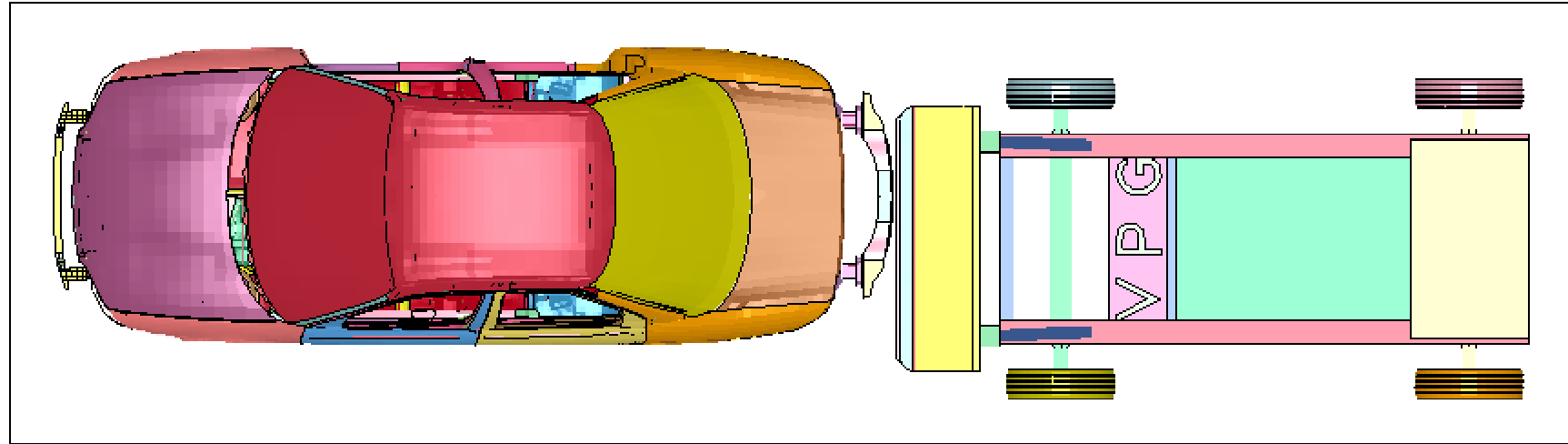
— : FEA — : Test

Test by HANWHA



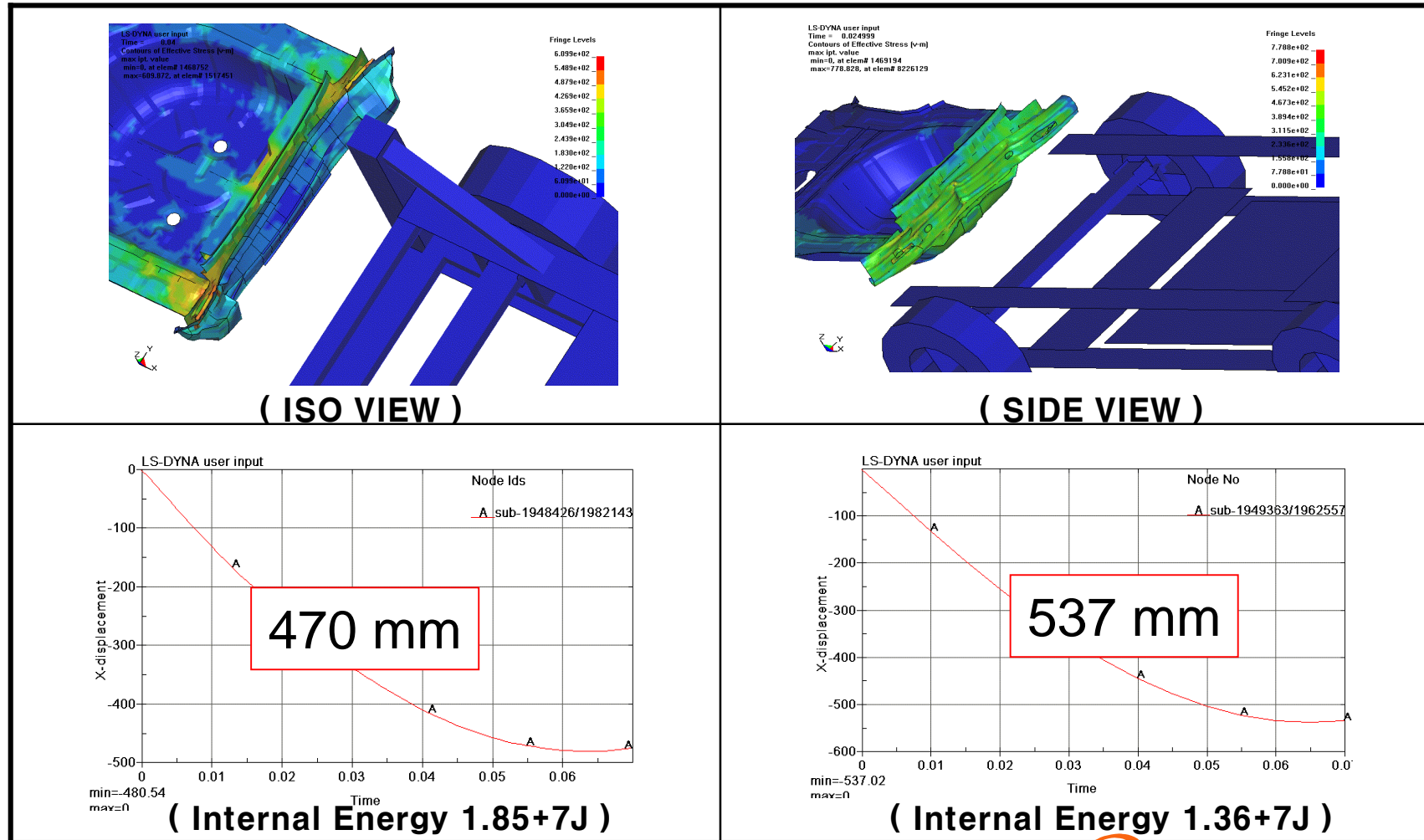
3. FMVSS301





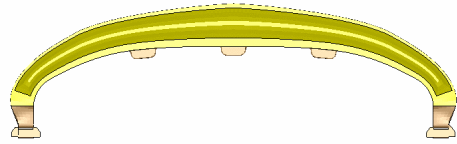
50MPH, MDB, 70% OFFSET BARRIER TEST

❖ Comparison with GMT vs. STEEL

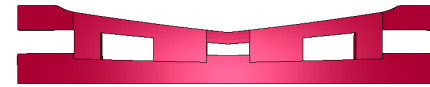


4. Pedestrian Bumper

❖ FEA design and Test by HANWHA (AI beam)



GMT pedestrian bumper



GMT pedestrian E/A

* #1 Prototype testing shows reasonable correlation to FEA.

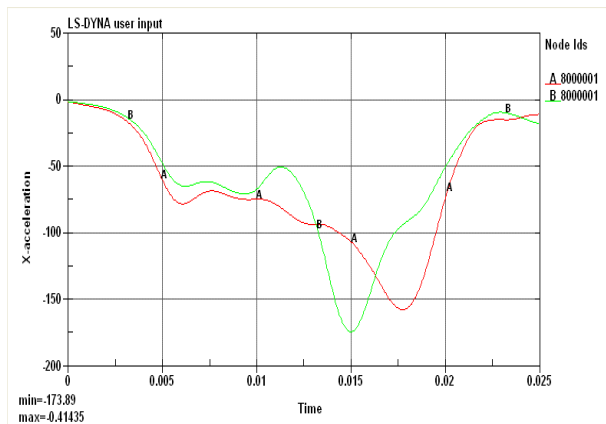
		Date	Acceleration	Bending Angle	Displacement
EURO NCAP SPEC.			200.0	21.0	6.0
IN-HOUSE SPEC.			160.0	16.8	4.8
FEA	0 L	07.2	141.2	15.1	2.4
	200 L	07.2	150.9	16.2	3.2
	360 L	07.2	158.7	16.5	3.1
#1 Proto TEST	0 L	07.5	140.8	16.1	3.4
	200 L	07.6	165.3	11.2	3.1
	360 L	07.6	157.0	16.9	3.1

❖ Comparison with GMT vs. STEEL

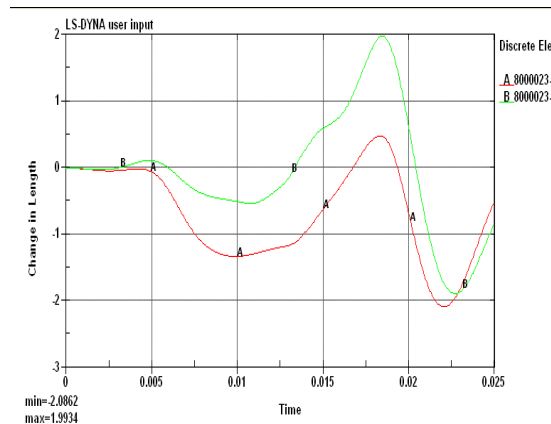
- The Stronger Impact Beam causes the higher injury probability on legform.
- green curve (steel/4.5Kg), red curve (gmt/2.0Kg)

% of Internal energy	GMT BEAM	STEEL BEAM
Legform	32.0	37.1
Impact Beam	17.0	7.3
E/ABS	17.7	18.7
Fascia	13.5	18.7
Stiffener	8.4	11.3

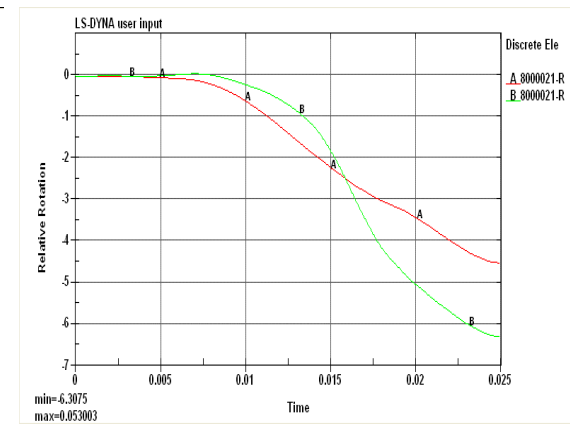
	GM/SPEC	GMT	STEEL
Tibia Acceleration (G)	160.0	157.0	173.9
Shear Displacement (mm)	4.8	2.08	1.99
Bending Angle (Degree)	16.8	4.5	6.3



TIBIA ACCELERATION



KNEE SHEAR DISPLACEMENT



KNEE BENDING ANGLE

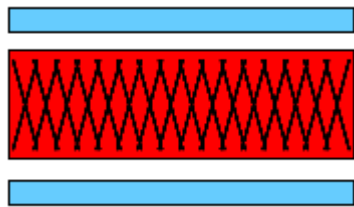
5. Crash Performances

1. Showed excellent performance at the NCAP Test
2. In case of 40% ODB Crash is Acceptable or Good Result.

	MY	Front Beam	Frontal Star Rating [NCAP] (based on risk of head & chest injury)		IIHS OFFSET 40% crash
			Driver	Passenger	
Hyundai XG350	2004	GMT	★ ★ ★ ★ ★	★ ★ ★ ★ ★	GOOD
Hyundai EF Sonata	2004	GMT	★ ★ ★ ★ ★	★ ★ ★ ★ ★	Acceptable
Kia Regal	2004	GMT	★ ★ ★ ★ ★	★ ★ ★ ★	Acceptable
SUZUKI VERONA [GMDAT MAGNUS]	2004	GMT	★ ★ ★ ★ ★	★ ★ ★ ★ ★	Acceptable
SUZUKI FORENZA [GMDAT LACETTI]	2005	GMT	★ ★ ★ ★ ★	★ ★ ★ ★ ★	Acceptable

❖ New Hybrid GMT Beam system

◆ HIMT GMT Sheet

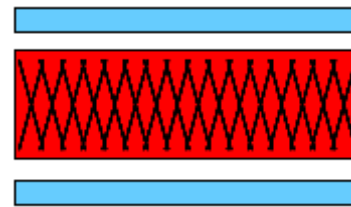


PP+GF Sheet

GMT Core

PP+GF Sheet

◆ IXIS Sheet



PP+GF Tape

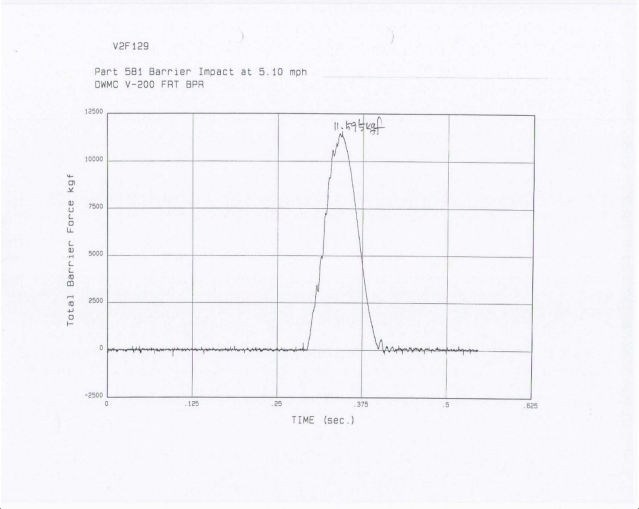
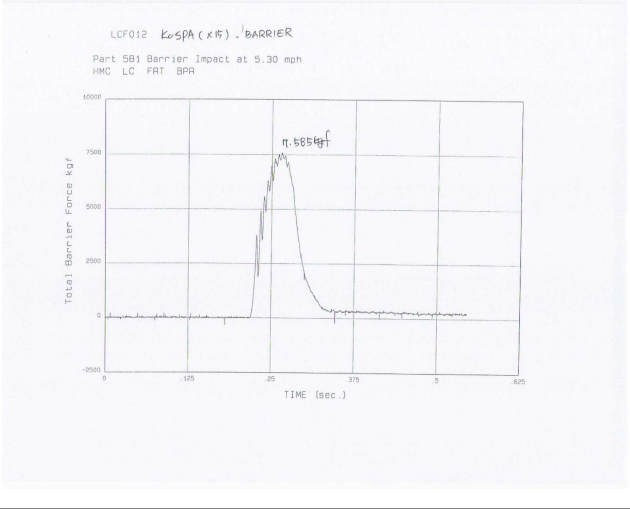
Chop Mat Core

PP+GF Tape

◆ Merit

- Mechanical property improving (20~30%)
- Beam Weight reduction (10%~)
- Crash Performance improving

4. Bumper Material Selection

	GMT < Hanwha GMT >	STEEL < Roll >
Vehicle	SUZUKI V-Car	HYUNDAI A-car
Force Curve	Elastic Rebound Big energy absorption 	Plastic Rebound Small energy absorption 

❖ Beam competitiveness

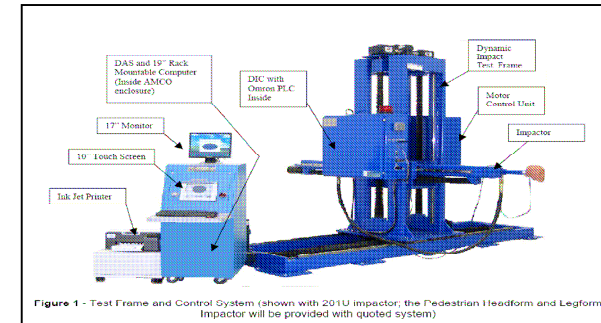
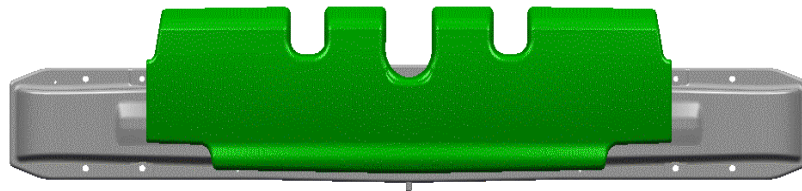
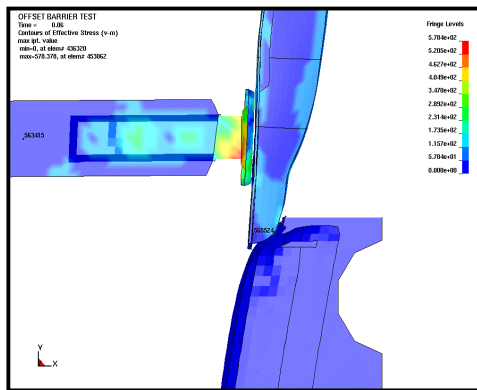
< based on 2008 >

	Steel Bumper System		GMT Bumper System		
	Weight	Cost	Weight	Cost (China)	Merit
Small	100		60~75	90	<ul style="list-style-type: none"> • Optimization • Test by HANWHA
Mid / Big			60~75	85	
SUV,RV			60~70	85	

	Aluminum Bumper System		GMT Bumper System		
	Weight	Cost	Weight	Cost (China)	Merit
Small	100		90~75	65	<ul style="list-style-type: none"> • Optimization • Test by HANWHA
Mid / Big			90~75	65	
SUV,RV			80~70	60	

5. Hanwha Capacity

- Raw material and Tier 1 Molder
- Design, FEA and Test for Optimization



Hanwha L&C Automotive Global Network

North America
 9. Hanwha North America
 London, Ontario
 Hanstone

North America
 8. Hanwha L&C Alabama
 Opelika, AL
 GMT and EPP

North America
 Azdel
 10. Fenton, MI
 11. Lynchburg, VA
 12. Shelby, NC

13. Czech Republic
 GMT and EPP

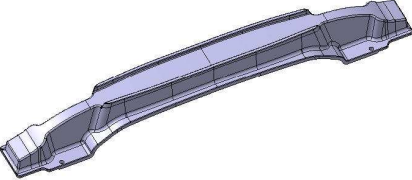


Korea
 1. Seoul
 Headquarters
 2. Jinhae
 Interior Skin
 3. Bukang 1
 TPU PMC
 4. Bukang 2
 GMT and EPP
 5. Dae-Jeon
 R&D Center

China
 6. Beijing
 GMT and EPP
 7. Shanghai
 GMT

14. India
 GMT and EPP

Hanwha Living & Creative (L&C)
 Corporation acquires AZDEL, Inc -2007

❖ New Stayless GMT Beam Design

	C - Type	Reverse - C type	H - Type
			
Material	HIMT>HANWHA UD45 > AZDEL UD42 > AZDEL R401 (Continuous Fiber)	HIMT>HANWHA UD45 > AZDEL UD42 > AZDEL R401	HANWHA UD 45 > AZDEL C507 + UD45 > AZDEL C507 (Chop Fiber)
Performance & Merit	IIHS (Best ~) + FMVSS -Good for 15% off-set IIHS -Small E/Absorber	IIHS (Good~) + FMVSS -Protect under-riding -Small E/Absorber	IIHS+ EC - Good for 40 % Offset RCAR
Vehicle	Sedan, RV, MPV	Sedan, RV, SUV	Sedan, RV, MPV
Merit	Weight down (60% of steel, 90% of Aluminum) Cost Down (90% of steel – Stayless Type)		

Conclusions

Total Solution Capabilities & Cost Effective Process Technologies

1. GMT Bumper system has excellent performances both low speed test and pedestrian protection test.
2. Vertically integrated from raw material to molded products
 - Glass mat, sheet manufacturing & molding technology
 - Innovative processing technology
 - Modify material property by mat structure & local reinforcement
3. Wide experience in design, development and test for impact beam.
 - R&D experiences in various national regulations & standards
 - Performance & cost optimization Design & FEA Analysis
 - CMVSS, FMVSS, EC, IIHS Test, R-CAR , Pedestrian, Crash
 - Various low speed impact test facilities for bumper system
 - Guarantee quality of bumper beam by periodic testing
4. Worldwide logistics capability (Korea, China, US, Europe)

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- ❖ SGM – *YongFei Shan*
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- ❖ Echo – *Choi Doowhan, Cho Inwhan*
- ❖ Hanwha – *Kim Namhyeong, Cho Heean, Lee Jun, Choi Wonjun, Kil Yongkil, So Cheolwon, Xiao Gao,*

- Questions & Answers
- Please also refer to jshin@azdel.com for any further questions

John(Dong won) Shin

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