

Honda's Study & Report on
the Study Commissioned by NHTSA
"Mass Reduction for Light-Duty Vehicles
for Model Years 2017-2025"
DTNH22-11-C-00193

Presented by Chuck Thomas
PUBLIC VERSION

NHTSA Mass-Size-Safety Workshop
May 13th-14th, 2013



HONDA

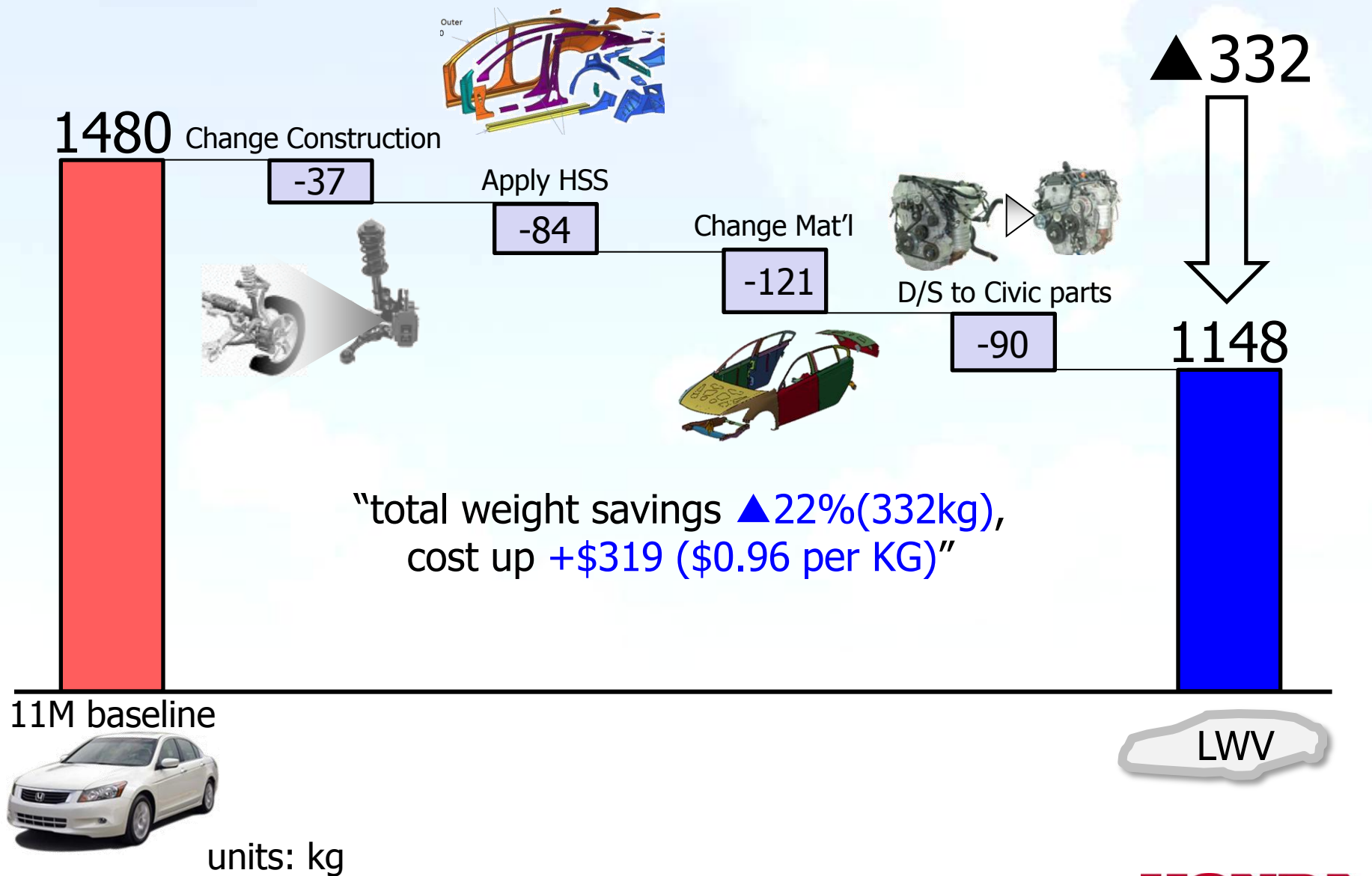
Honda's Observations on LWV Study

- The EDAG/GWU Report is a good study of light weighting possibilities.
- Many of the technologies and approaches to light weighting in the report reflect Honda's own research and direction.
- This report by Honda is an effort to share with NHTSA and others our important observations and corrections with respect to both the details of the report, and its conclusions.
- Honda believes that by sharing our thinking, we can improve NHTSA's policy-making to reflect more realistic and practical considerations from industry.

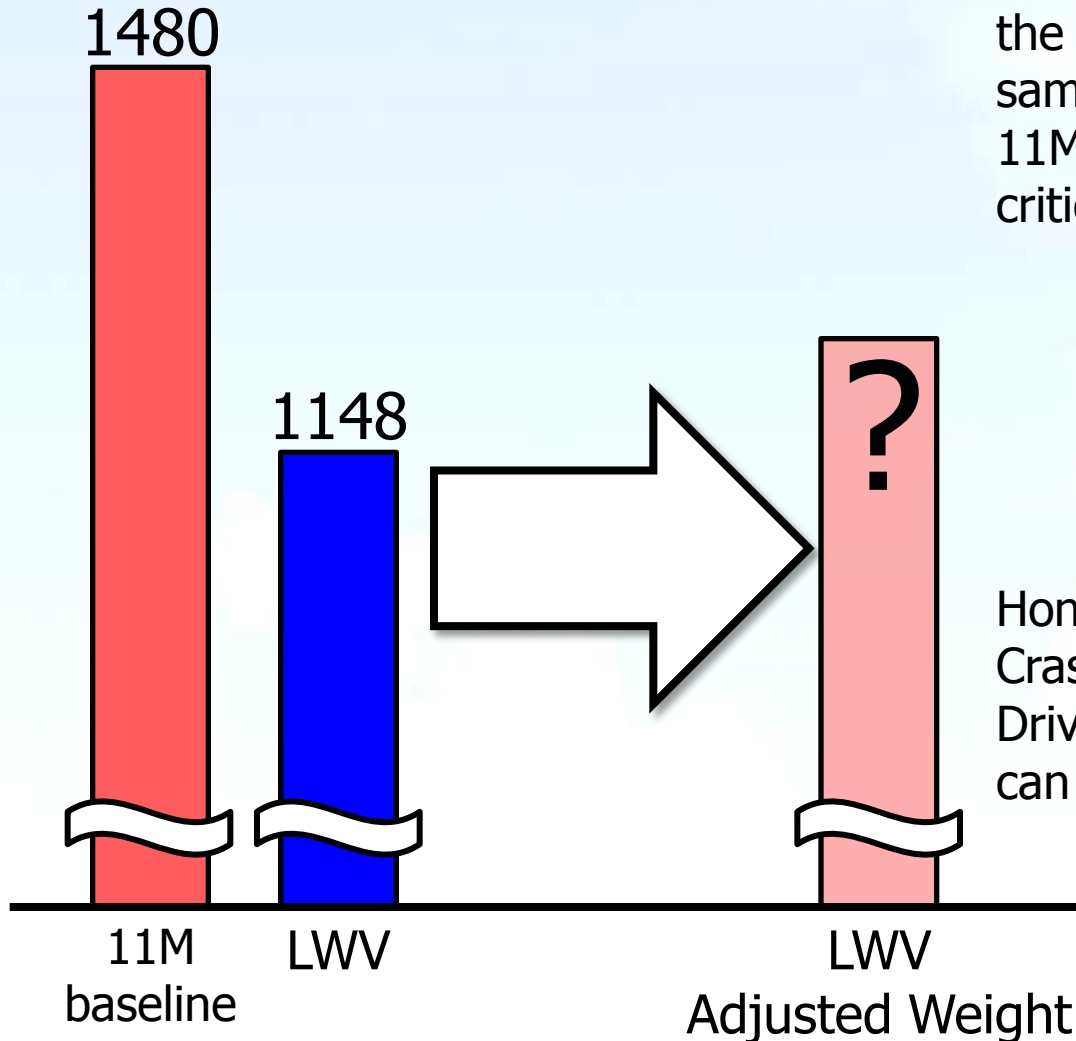
Honda's Observations on LWV Study

- Honda believes that the LWV design would not achieve performance parity with the 2011 Accord in the areas of:
 - Crashworthiness
 - Performance & Drivability
 - Ground Clearance
- Business conditions not considered by EDAG would result in increased weight of the LWV:
 - Platform Commonality
- Mass added to the vehicle to correct for performance and platform issues will result in a mass rebound effect that will add additional mass.
 - Power-train downsizing

Summary of LWV Mass Reduction



LWV Parity With Accord

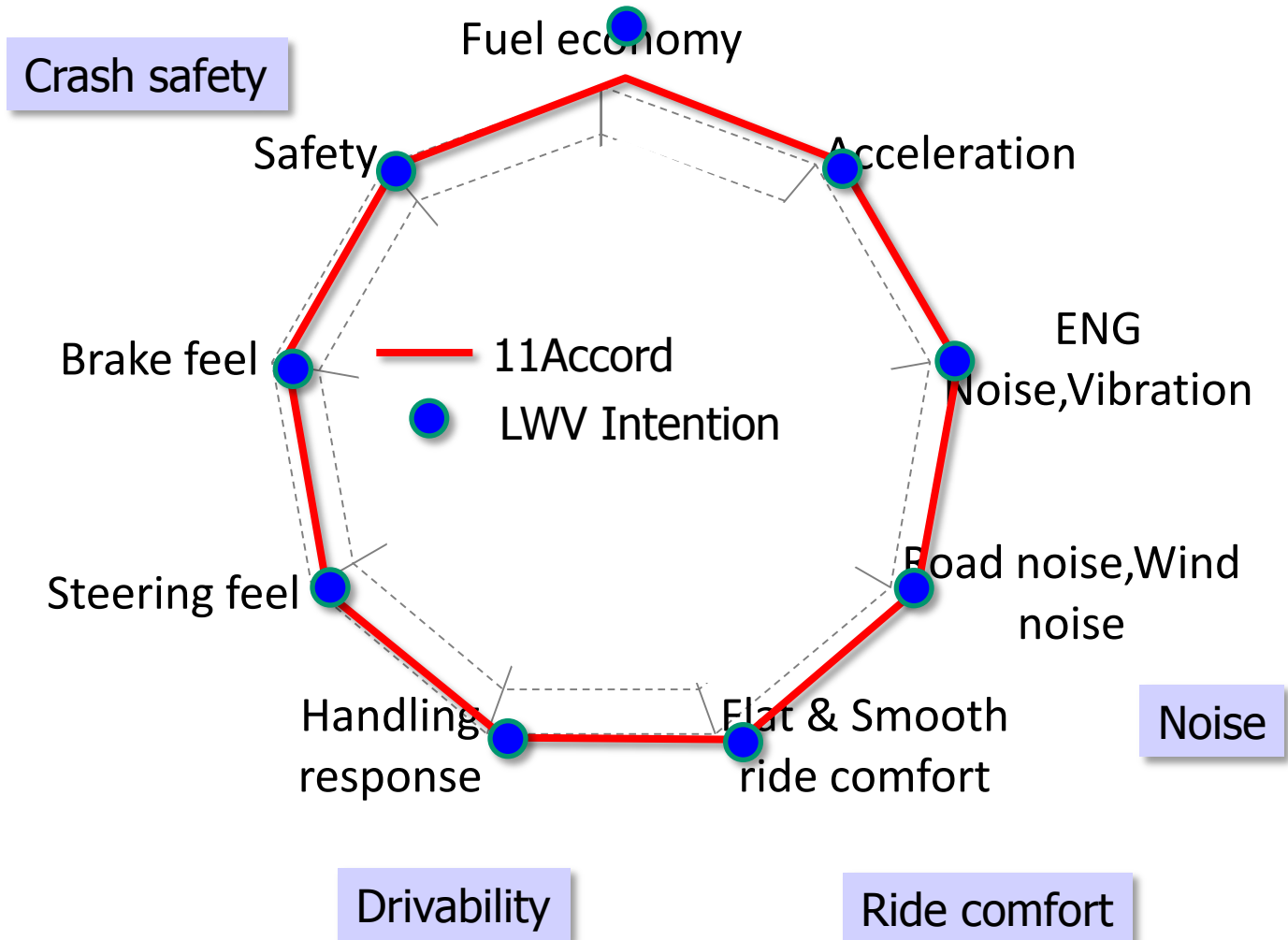


Honda observes that the goal of the LWV design – to achieve the same level of performance as the 11M Accord – fell short in two critical areas:

- Crashworthiness
- Drivability & Performance
 - Handling
 - Ride Comfort
 - Ground Clearance

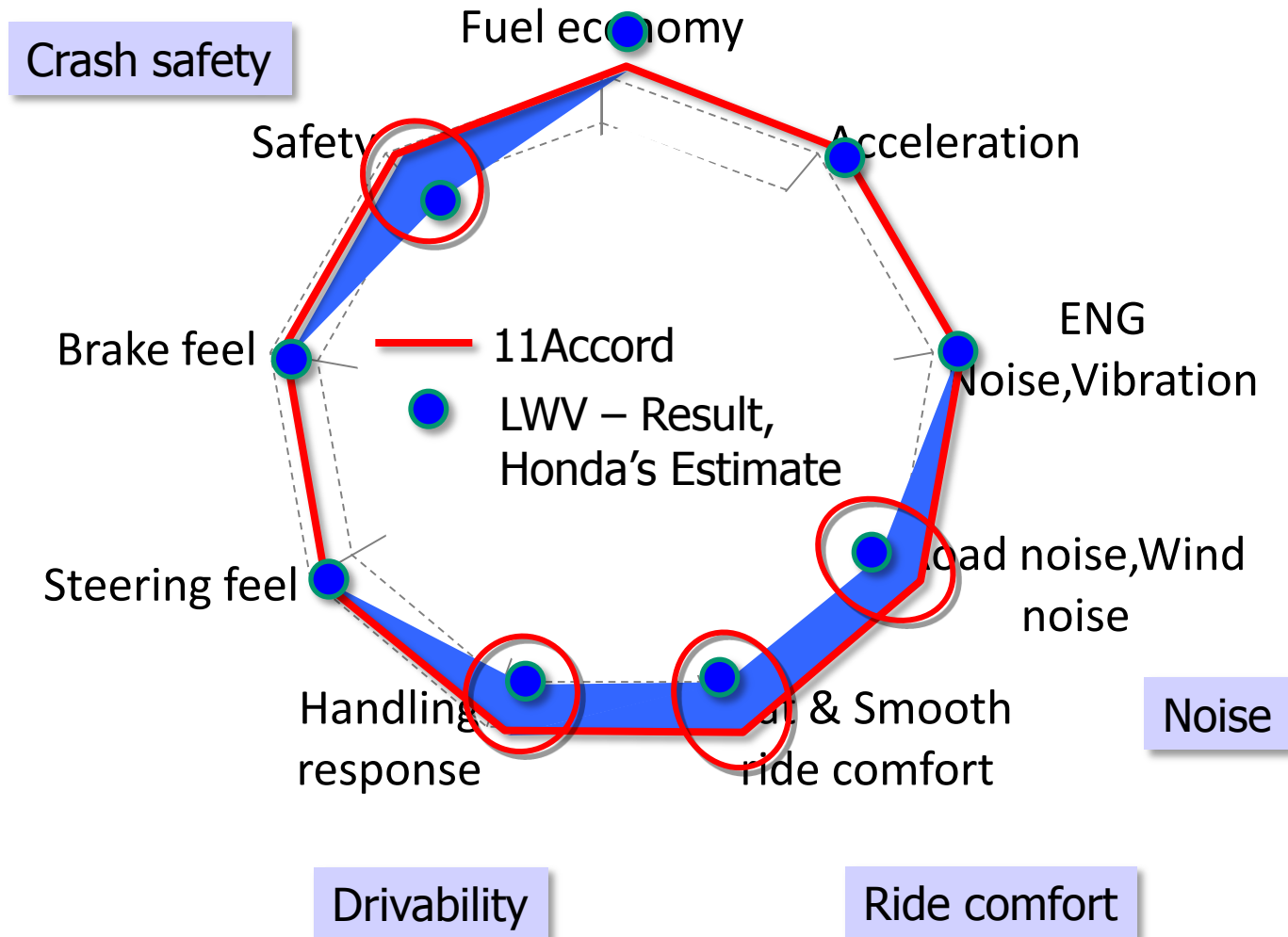
Honda finds that by solving the Crash Worthiness performance, the Drivability performance (stiffness) can be addressed.

Performance – Intention of The Study



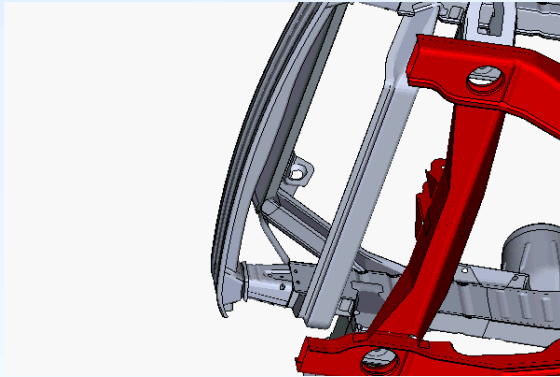
Performance – Honda's Judgment

Honda's judgment is based study of the report, discussion with the researchers (Dec `12), and Honda's own internal study, research and analysis

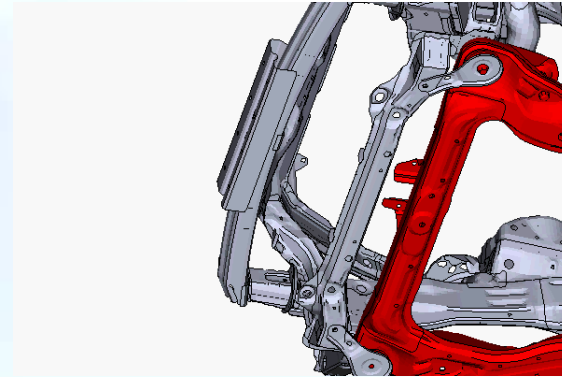


Crashworthiness Issues

Precondition for countermeasures

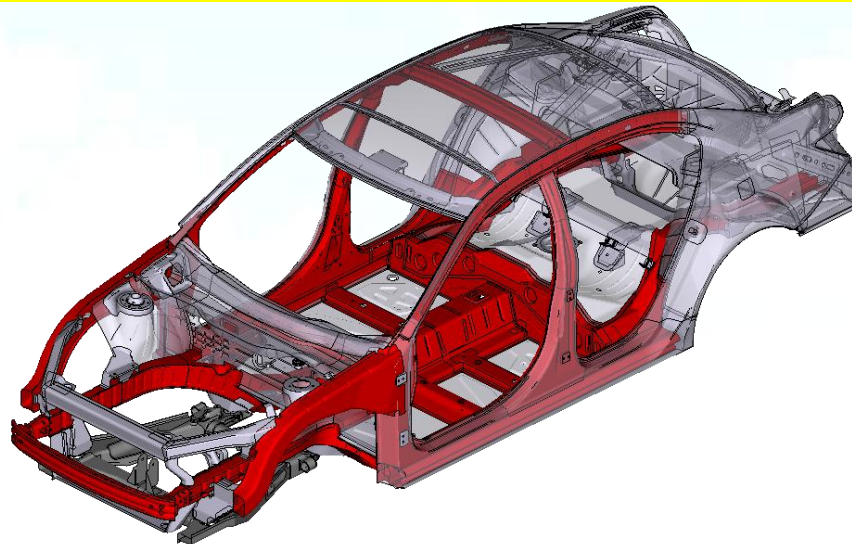


LWV ; Sub-frame is designed to engage during crash event



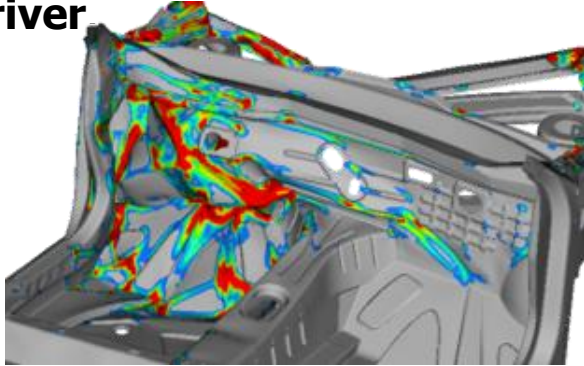
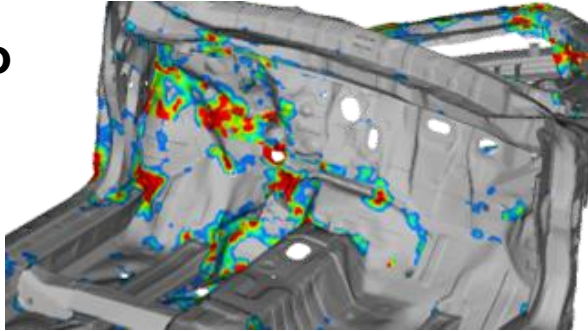
ACCORD ; Sub- frame is designed to disengage during crash event

Countermeasures is performed in the LWV sub-frame engagement system

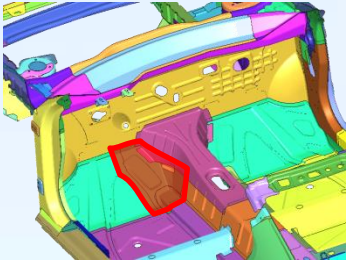
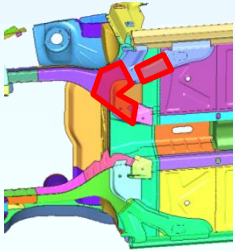
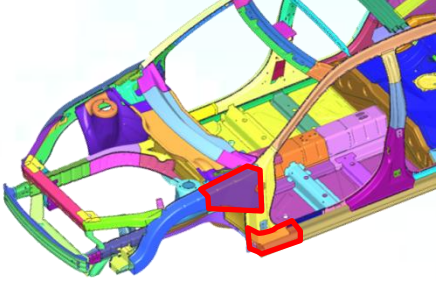



Countermeasure is performed by change of material and thickness on the LWV BIW structure

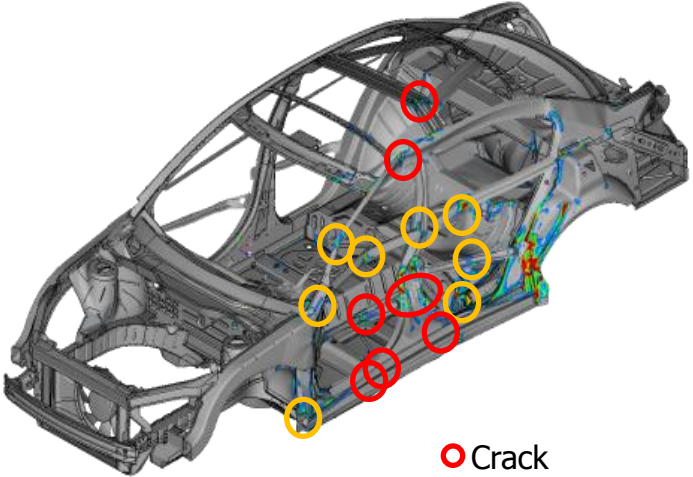
Frontal Crash Safety Performance

	TEST Target	Issues	Judgment
FRONTAL	IIHS GOOD	<p>On the whole, dashboard, lower (firewall), pedal area intrusion and deformation – impacting lower extremities is larger on LWV than ACCORD, resulting in more injury risk to the driver</p> <p>LWV</p>  <p>ACCORD</p> 	<p>MARGINAL (leg/foot, right)</p> <p>Countermeasure Required</p>

Improving Frontal Crash Performance

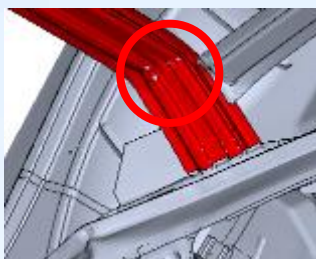
Area		COUNTERMEASURES
TOE BOARD (RIGHT FOOT)		TOE BOARD increase strength with additional STIFFENER to prevent out-of-plane deformation
FRONT RAIL END		FRONT RAIL END increase strength with additional STIFFENERS
WHEEL HOUSE UPPER MEMBER FR PILLARUPR FR PILLARLWR SIDE SILL		<ol style="list-style-type: none"> 1.Increase FR W/HOUSE UPR MBR strength to prevent FR W/HOUSE intruding into DA/BD LWR. 2.Adjust the PLRs and S/SILL strength up, according to the W/HOUSE UPR MBR stiffener
SEAT FOOT		Increase the SEAT FOOT strength to prevent seat pitching seen in LWV model <div style="background-color: yellow; padding: 5px; display: inline-block;">+25Kg</div>

Side Crash Safety Performance

	TEST Target	Issues	Judgment
SIDE	IIHS SICE GOOD	<p>Hard to maintain integrity of the safety cage due to many predicted fractures</p>  <p>○ Crack ○ Limit of elongation</p>	<p>In order to maintain integrity of the safety cage from potential harmful fractures, especially considering mass production variability, this solution is not acceptable (too marginal)</p> <p>Countermeasure Required</p>

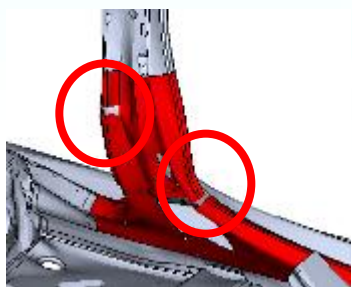
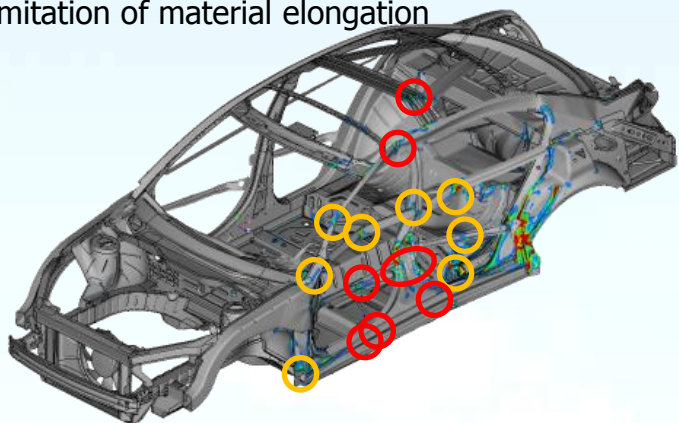
Improving Side Crash Safety Performance

ROOF ARCH



○ Cracked portion

○ Limitation of material elongation

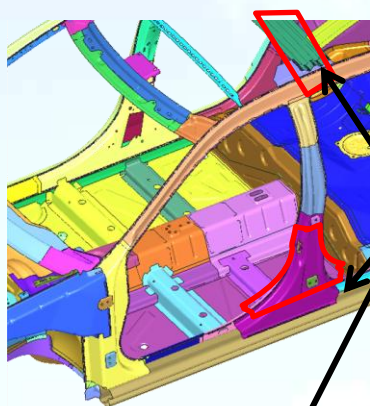


CTR PLR, INN



CTR PLR, STIFF

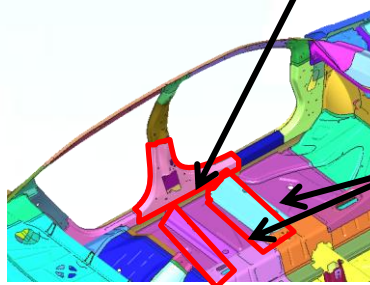
Countermeasure



To prevent the material fracture

1. Apply better elongation material (lower Yield strength) to the large deformation portion on LWV

2. Adjust LWV thickness equal to the ACCORD thickness



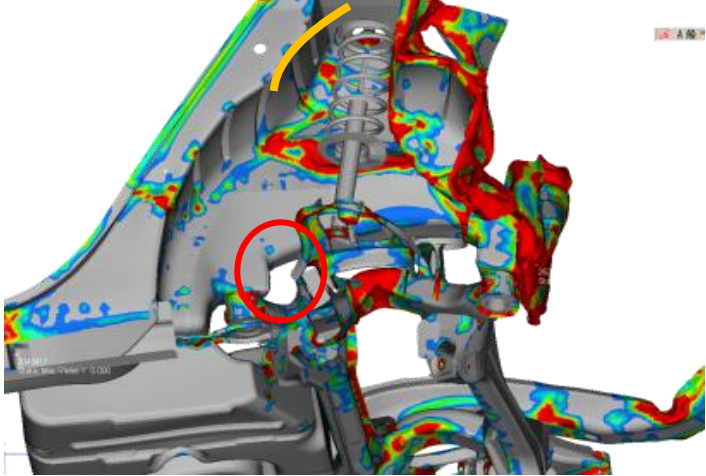
3. Adjust the cross member thickness to transfer the bigger side impact load according to the CTR PLR countermeasures

+10Kg

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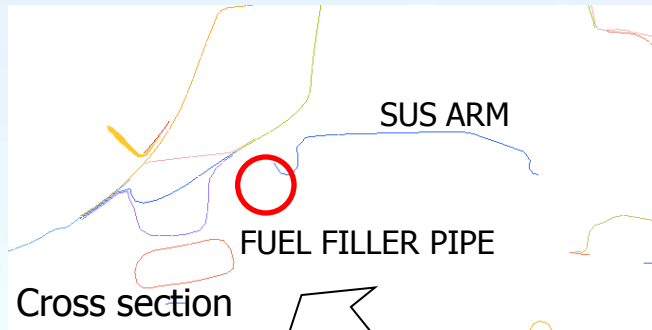
Goal: Maintain integrity of the safety cage

Rear Crash Safety

	TEST Target	Issues	Judgment
REAR	FMVSS 301 No fuel leak	<p>Fuel pipe and the edge of Rear suspension upper arm interfere</p> <p>GWU did not include fuel filler pipe in their simulation. When Honda added the fuel filler pipe to the simulation, deformation occurred</p> 	<p>Fuel filler pipe deformation and potential damage is unacceptable for a simulation.</p> <p>Countermeasure Required</p>

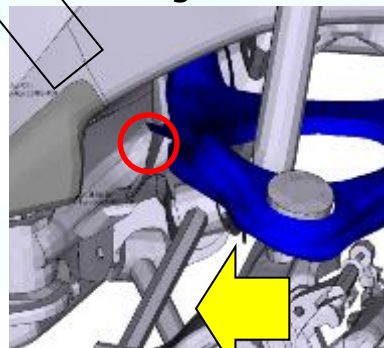
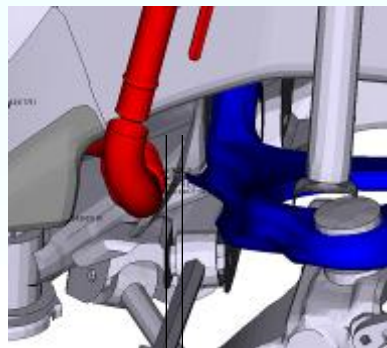
Rear Crash Safety Improvement

Fuel pipe and the edge of Rear Suspension upper arm interfere



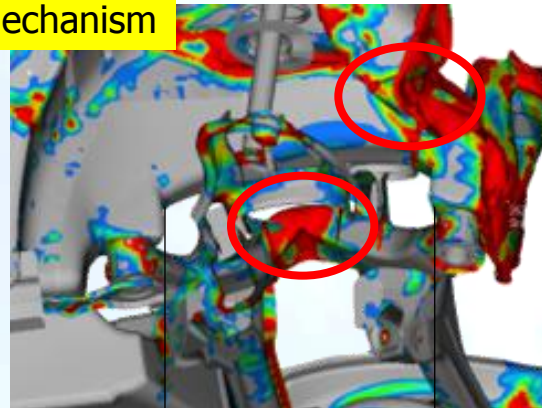
Before test

During test



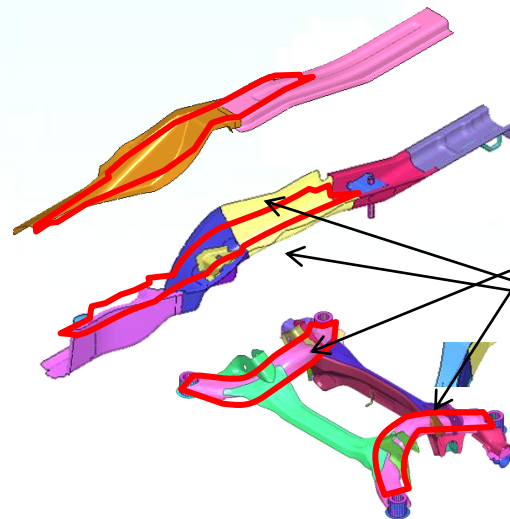
Note: LWV CAE model is not equipped with fuel filler pipe. Honda merged it from ACCORD CAE model

Mechanism



Reduce the deformation between Fr and Rr sub frame brackets

Countermeasure



+15Kg

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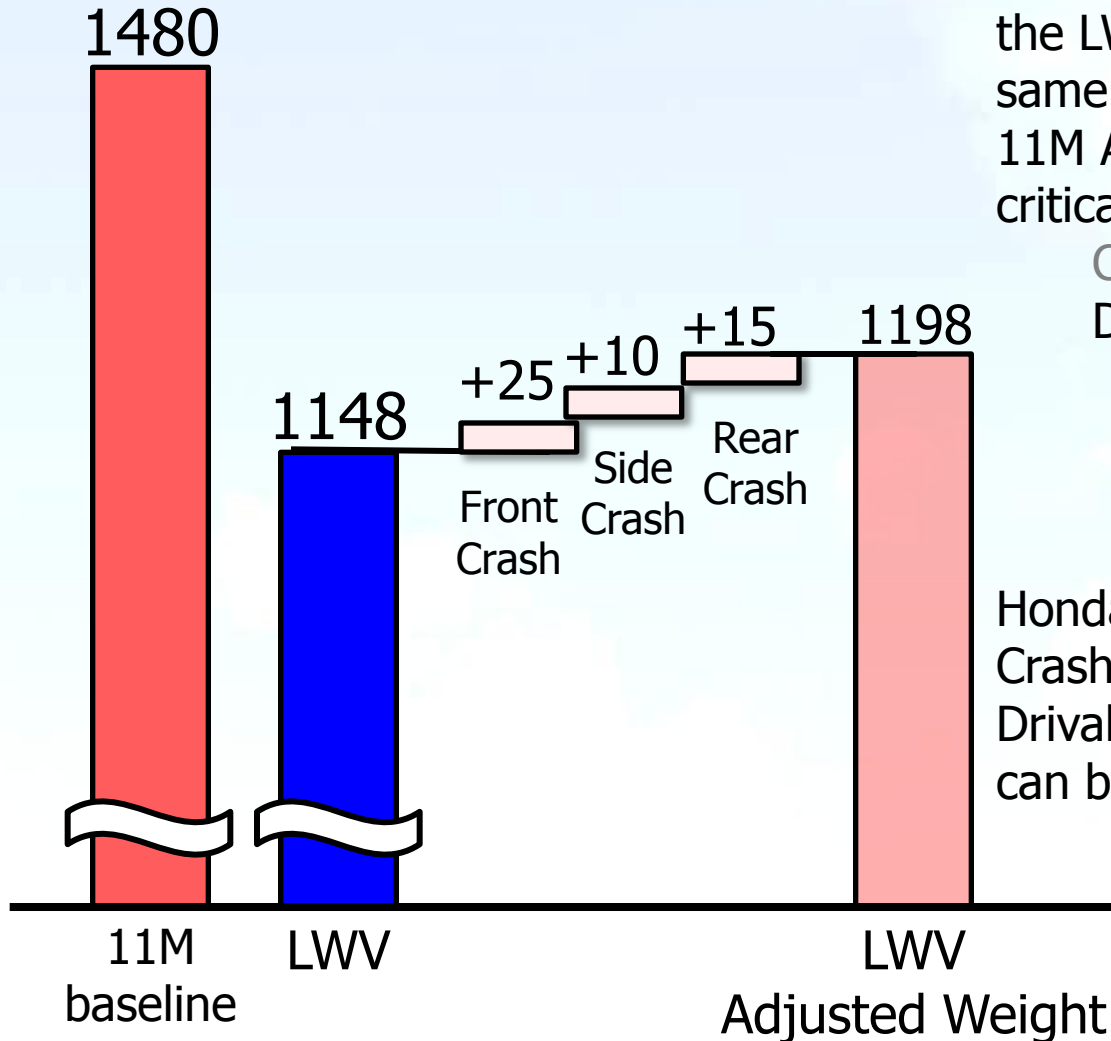
Countermeasures to eliminate the possibility of fuel leak

Safety Countermeasures : 50 Kg

Honda observes that the goal of the LWV design – to achieve the same level of performance as the 11M Accord – fell short in two critical areas:

- Crashworthiness
- Drivability & Performance
- Handling
- Ride Comfort
- Ground Clearance

Honda finds that by solving the Crash Worthiness performance, the Drivability performance (stiffness) can be addressed.

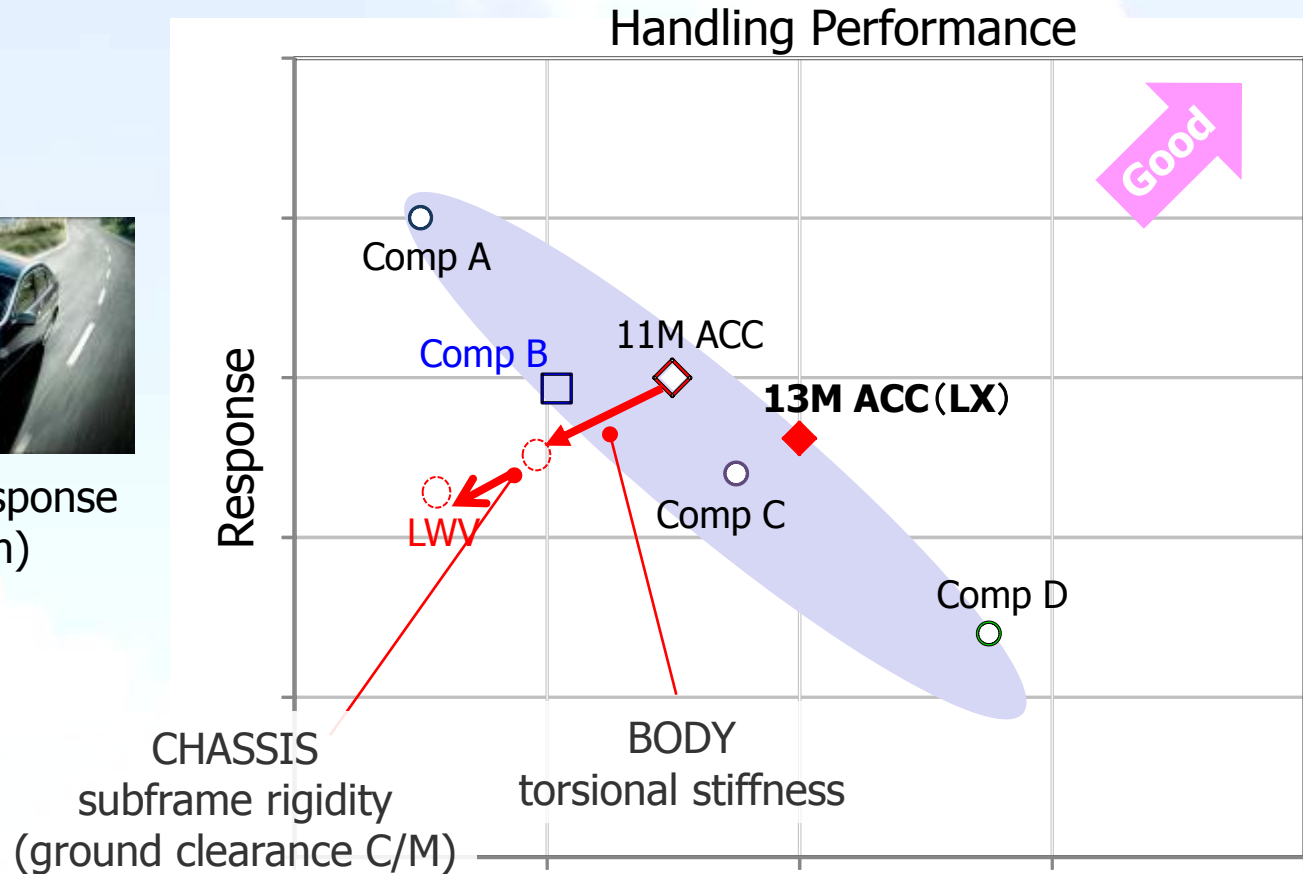


units: kg

Drivability & Performance : Handling



Steering Response
(turn-in)



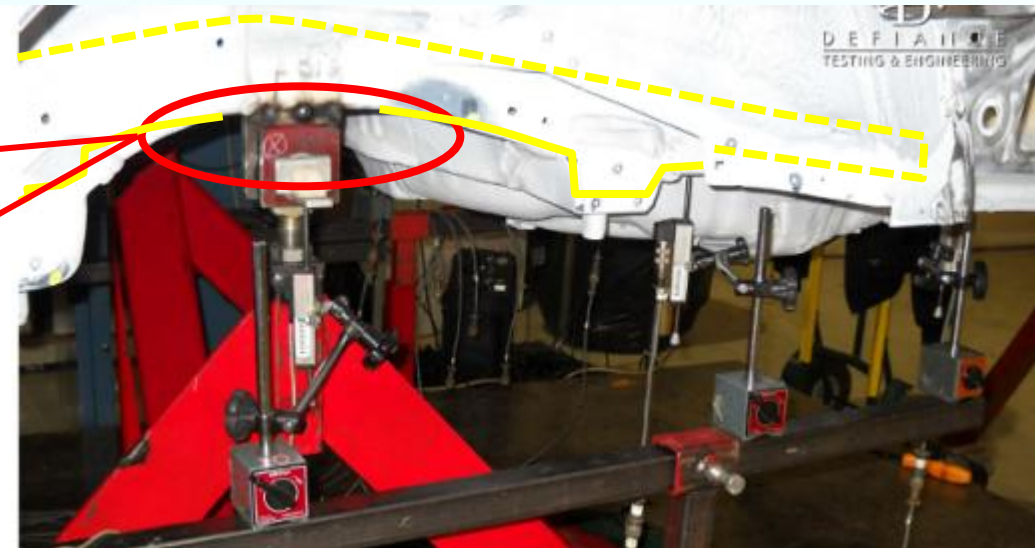
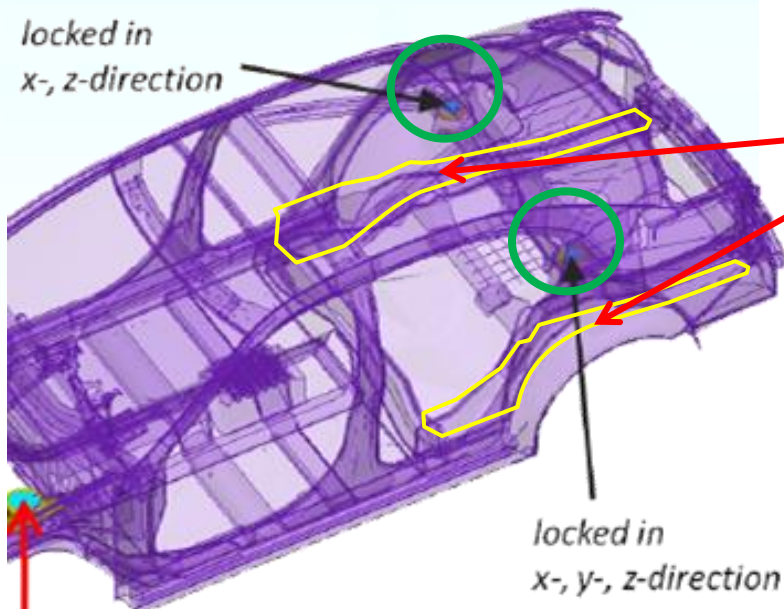
Recovery from Steering Maneuver

Drivability: Torsional Stiffness

1. LWV physical test of Torsional stiffness values for ACCORD are significantly low compared to Honda's internal data.

Torsional Stiffness [kNm/deg]	Physical test	CAE result
LWV	12.33	16.25

2. DEFIANCE's rear support locations for their physical test are unusual.



EDAG Report – Actual test picture – jigs are welded to the REAR FRAMES

**CONVENTIONAL SUPPORT POSITIONS
REAR SHOCK TOWERS**

**UNCONVENTIONAL SUPPORT POSITIONS
REAR FRAME**

HONDA

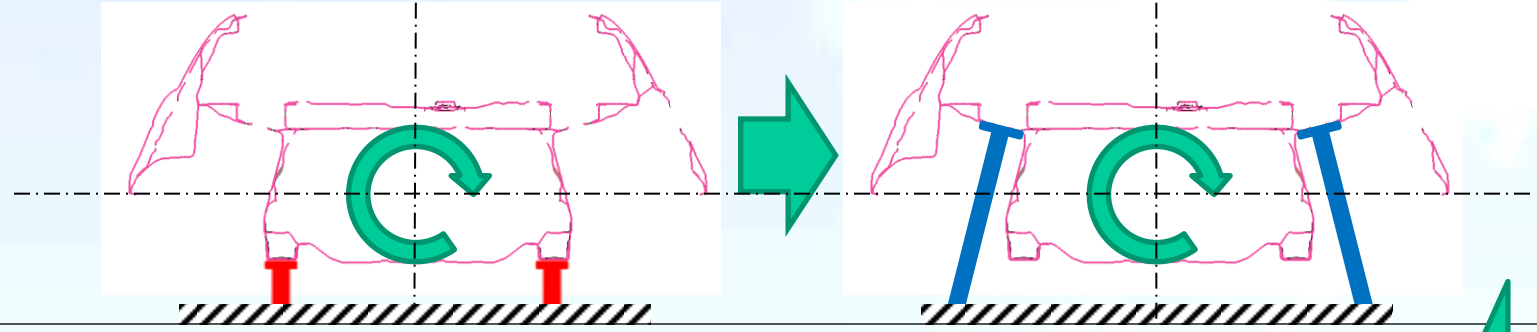
Drivability: Torsional Stiffness

Body torsional stiffness conclusion

LWV

Physical test (Target setting)

CAE result (Development)



Torsion Stiffness [kNm/deg]

12.33

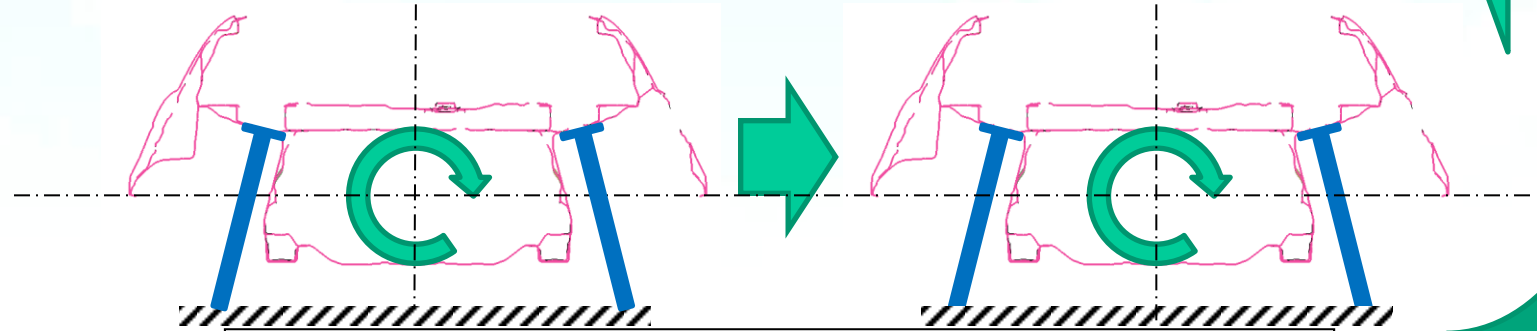
(TARGET 12.5)

16.25

HONDA

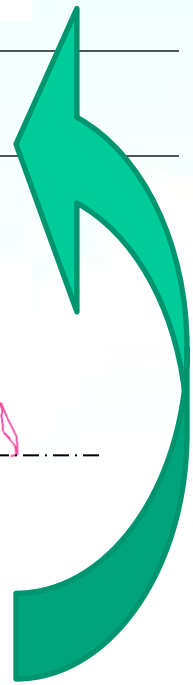
Physical test

CAE result



Torsion Stiffness [kNm/deg]

Deleted

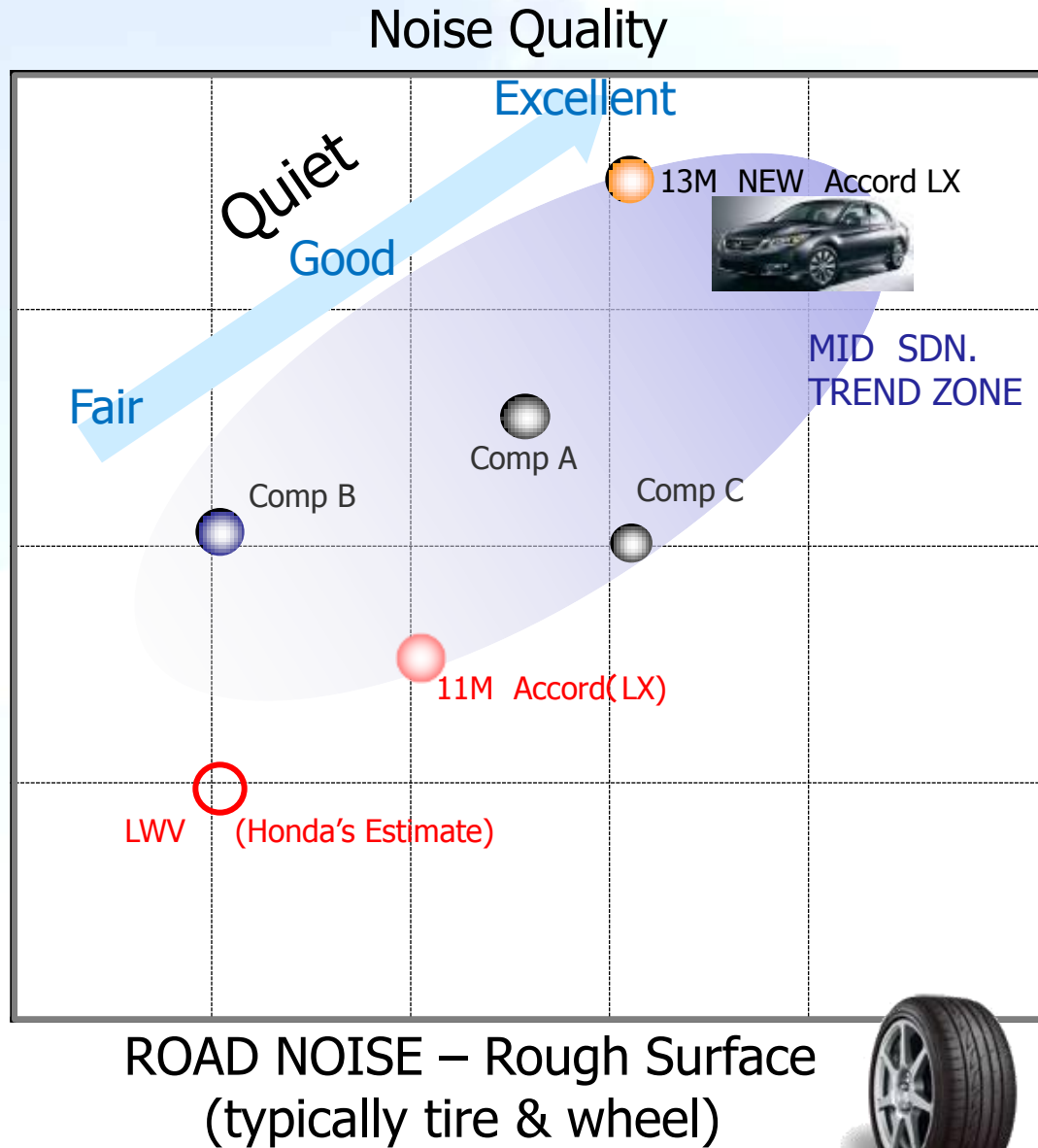
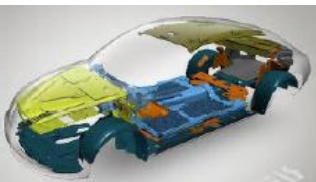


LWV body torsional stiffness is more than 25% lower than ACCORD
The Safety-Countermeasures (50kg) already address this issue.

Ride Comfort : Noise


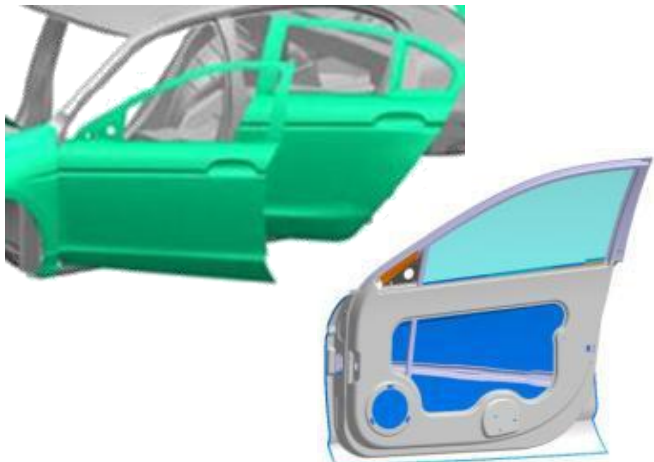
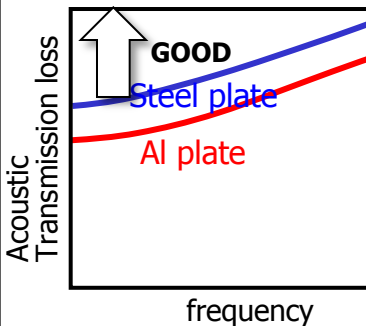

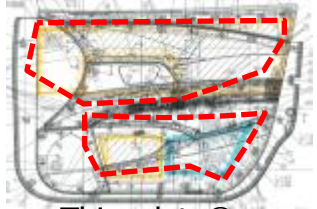


CRUSING NOISE – Flat Surface
(Acoustic Insulation)



HONDA

Ride Comfort : Noise

	LWV proposal	Concerns	C/M	Additional wt.									
Chassis	<p>Reducing thickness of Wheel Rim</p> <table border="1"> <thead> <tr> <th></th> <th>Baseline Vehicle</th> <th>LWV</th> </tr> </thead> <tbody> <tr> <td>Rim Thickness (mm)</td> <td>2.6</td> <td>2.40</td> </tr> <tr> <td>Disc Thickness (mm)</td> <td>3.5</td> <td>3.00</td> </tr> </tbody> </table> 		Baseline Vehicle	LWV	Rim Thickness (mm)	2.6	2.40	Disc Thickness (mm)	3.5	3.00	<p>Uncompetitive road noise vs. 11 Accord</p>	<p>Return to original thickness</p>	<p>+4.6Kg</p>
	Baseline Vehicle	LWV											
Rim Thickness (mm)	2.6	2.40											
Disc Thickness (mm)	3.5	3.00											
Insulation	<p>Aluminum Outer/Inner Door panel</p> 	<p>Uncompetitive cruising noise vs. 11 Accord</p> 	<p>Add insulation materials</p>   <p>Thinsulate®</p>	<p>+1.2Kg</p>									

Additional +5.8kg is necessary for C/M of Noise.

Ground Clearance

LWV Proposal

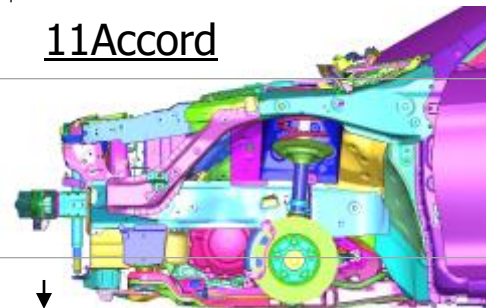
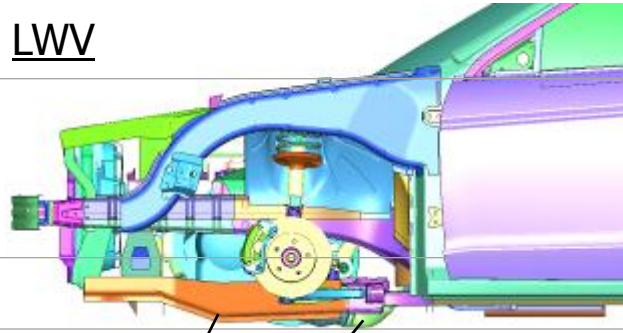
Honda Design

C/M

C/M
Wt

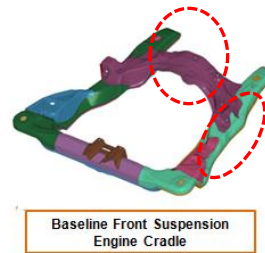
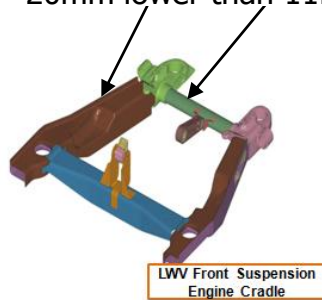
LWV

11Accord



LWV Ground Line Clearance is 20mm lower than 11M ACC

• Section area reduction by escaping exhaust pipe line

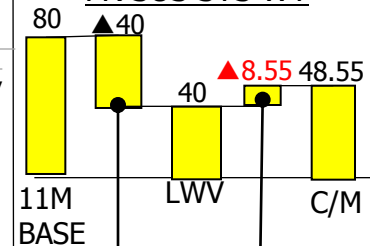


SUB/F thickness up & Change lower arm connecting structure

8.55Kg

FR SUS SYS

FR SUS SYS WT



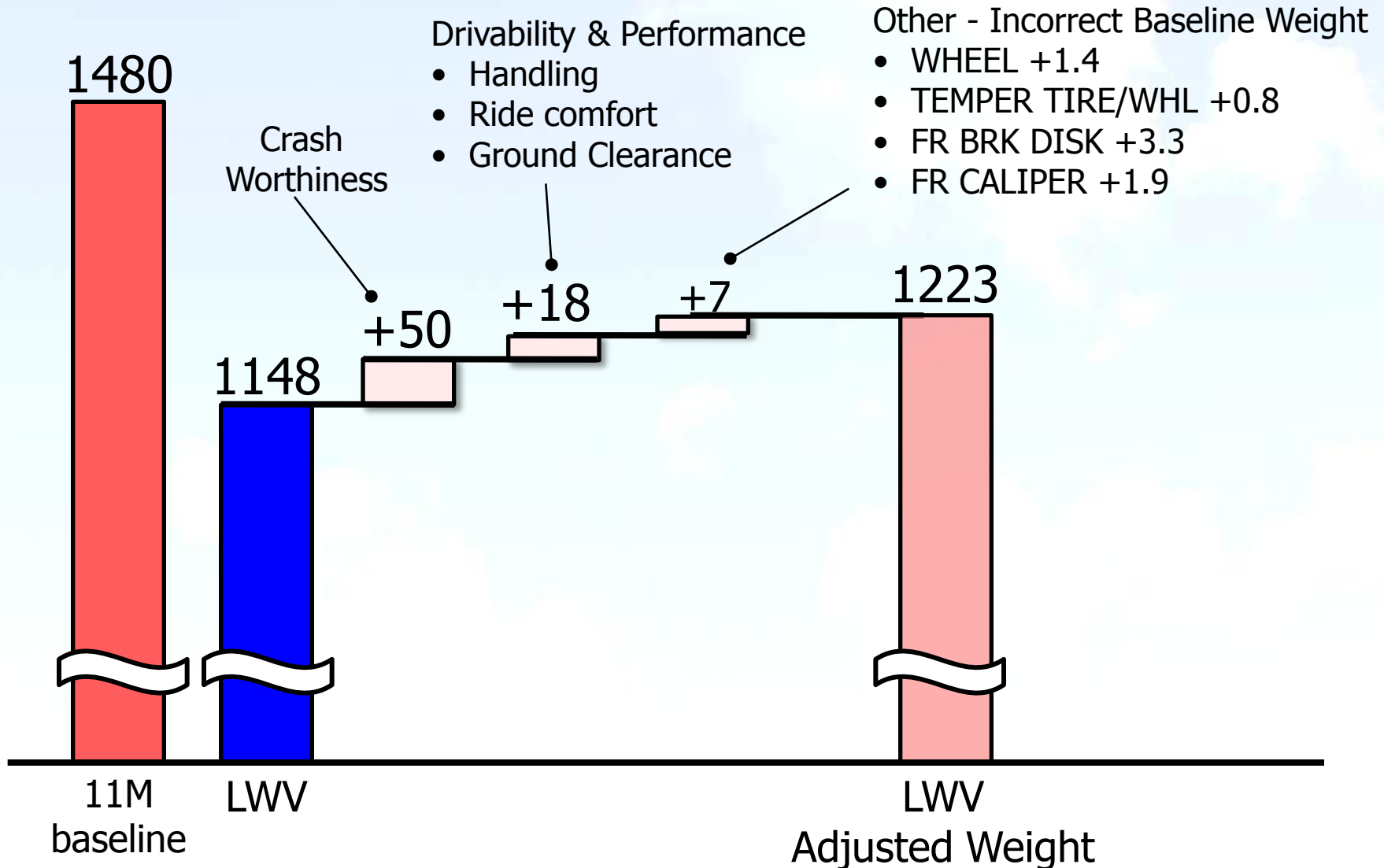
• Structure Change
• Material Change

G/L Clearance C/M

LWV Design is lighter and stiffer, but results in lower exhaust pipe (due to straight cross member), and taller side member – both of which contribute towards lower ground clearance. **Inadequate ground clearance can result in hitting objects, suspension damage, etc.**

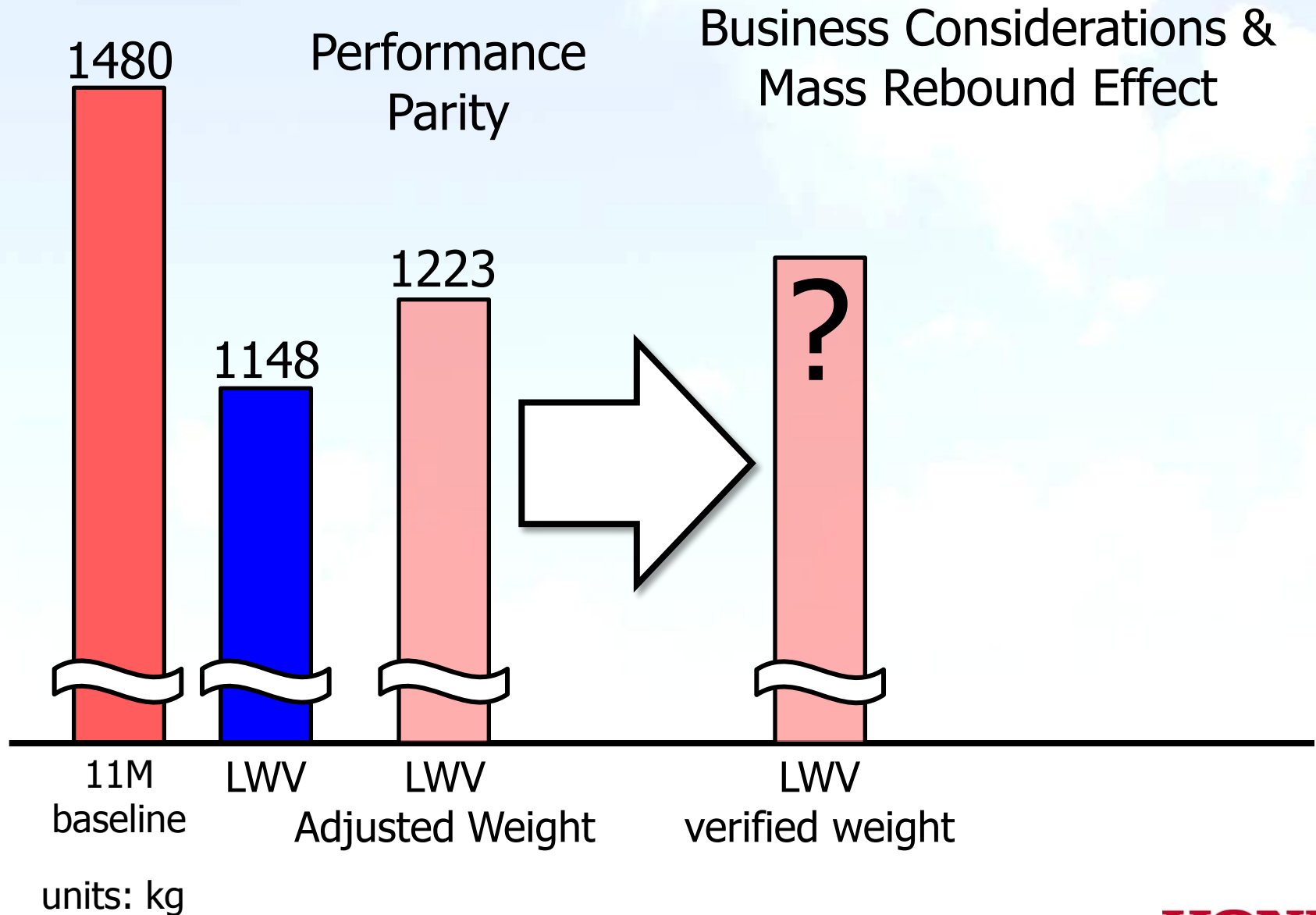
Honda's countermeasure for the LWV design is a bit heavier in order to recover the ground clearance.

LWV Adjustments : 75 Kg



units: kg

LWV Weight Adjustments



Automaker's Business Condition

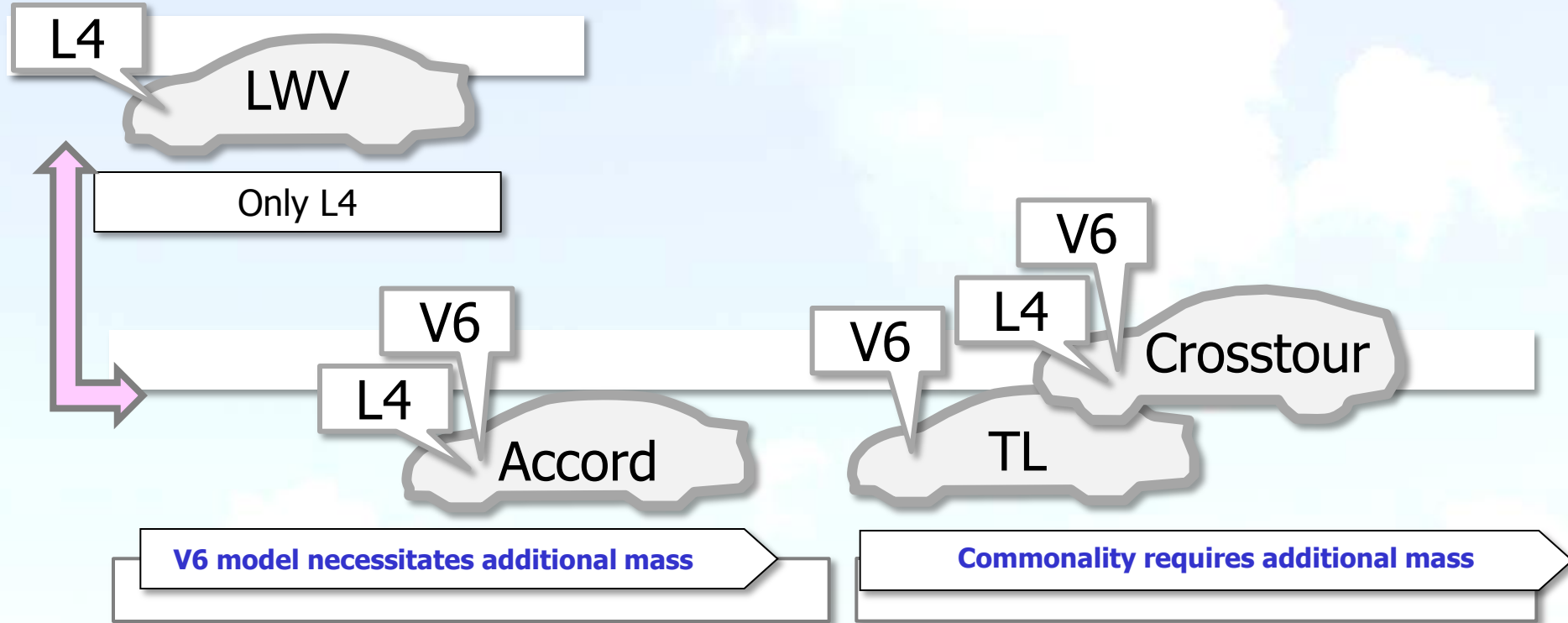
We OEMs must pay attention to provide products at an affordable price;

→ Taking advantage of platform commonality



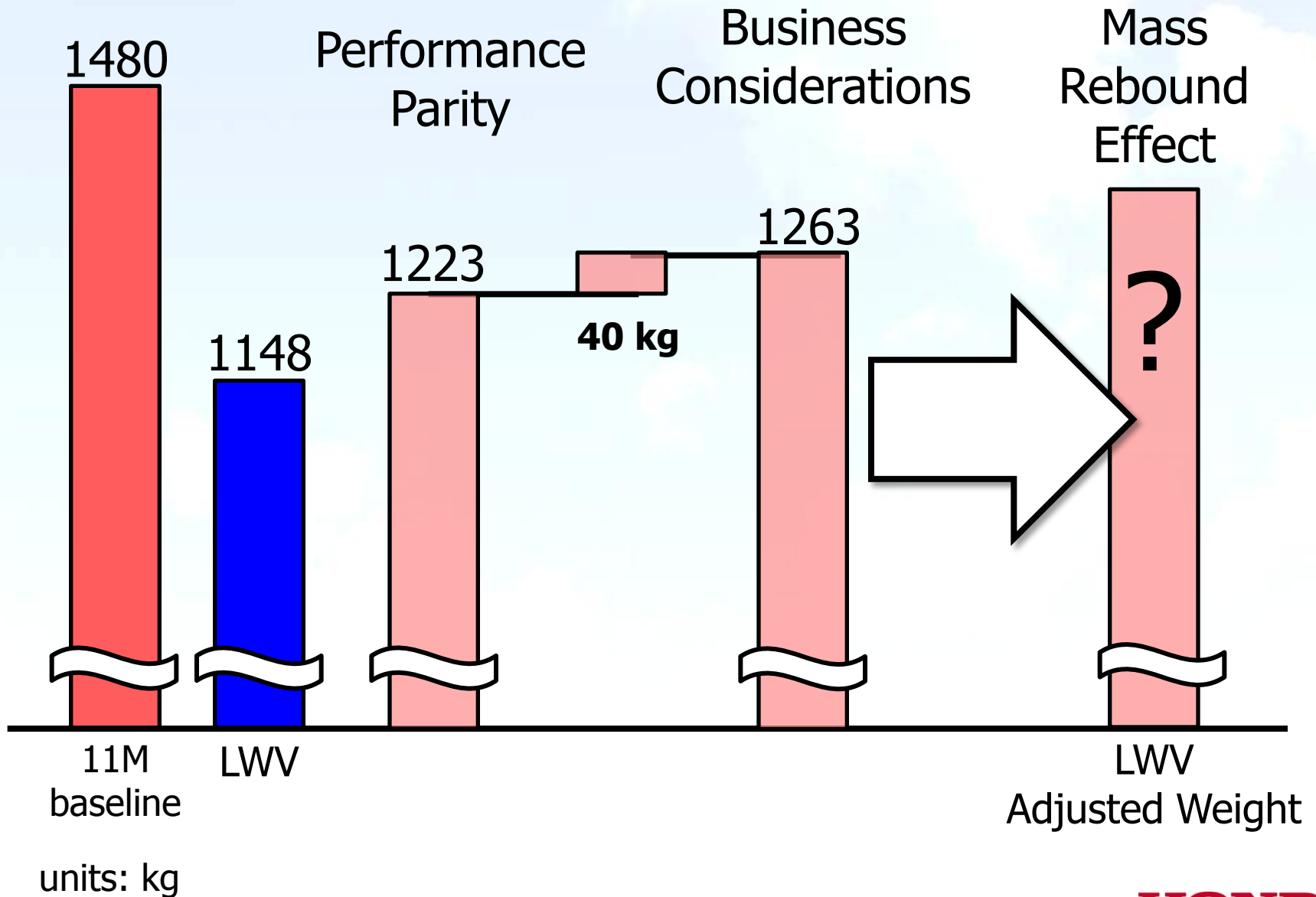
When using a common platform it is necessary to consider heaviest vehicle

Commonality Effect on Weight



Estimated weight impact is approx. 40kg.

LWV Weight Adjustments : 40 Kg



Mass Rebound Effect

These items are based on 332kg mass reduction

System		baseline wt.	LWV wt.	mass reduction
PT	ENG	169.9	141.3	28.6
	TMISS	96.7	68.8	27.9
	DR/SH	15.2	11.7	3.5
STRG	STRG SH+	17.3	12.9	4.4
	P/S UNIT	5.5	4.7	0.9
BRK	FR DISK	16.0	10.2	5.9
	ABS	3.1	1.9	1.2
	FR PAD	1.8	1.5	0.3
	Vacuum Pump	1.0	0.8	0.2
	RR PAD	0.9	0.8	0.1
	RR DISK.	8.2	5.2	3.0
EXH	EXPI+CAT+SLNCR+H/B	20.8	19.0	1.7
COOLING	Expansion bottle	1.1	1.0	0.1
	RAD support	0.4	0.4	0.03
	HOSE	1.8	1.5	0.3
	RAD	4.4	4.0	0.4
	FAN	7.1	6.0	1.1
ELEC	BATT	12.4	11.3	1.1
FUEL	F/Tank	12	10.3	1.7
	Gas	50.9	43.5	7.4



contribute to...

Acceleration Performance



Vehicle mass

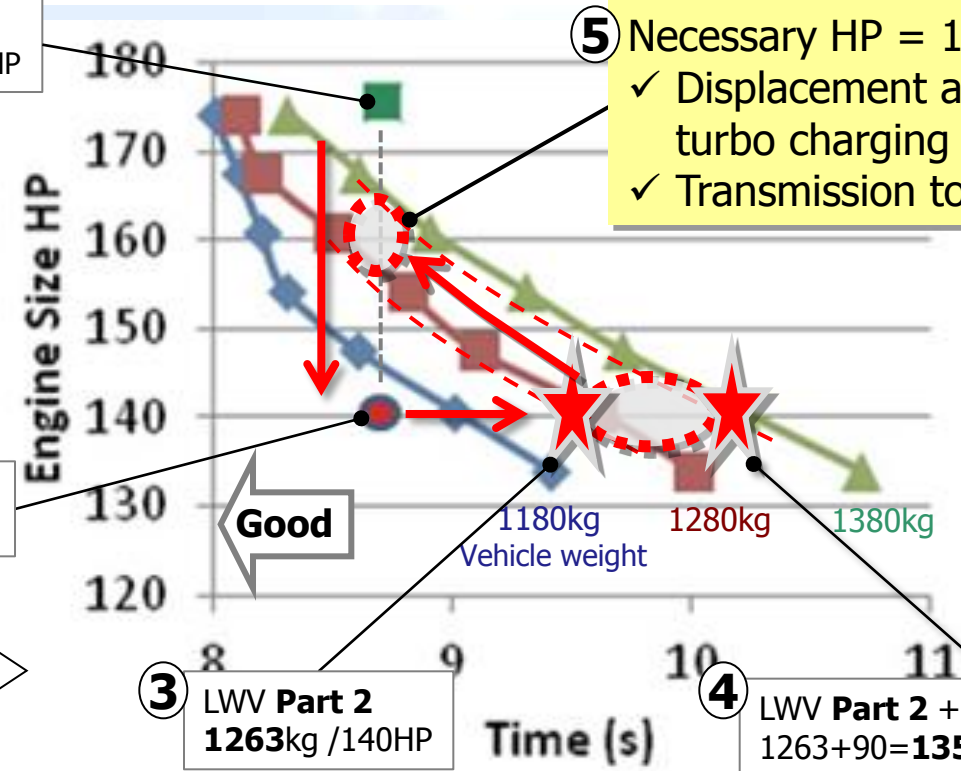
90kg

Power Train & Mass Rebound Effect

Acceleration Performance

Fig.98: Acceleration 0-60mph Time versus Engine Power

Vehicle mass



① baseline
1480kg/177HP

② LWV proposal
1148kg/140HP

③ LWV Part 2
1263kg /140HP

④ LWV Part 2 +NO downsize items
1263+90=1353kg /140HP

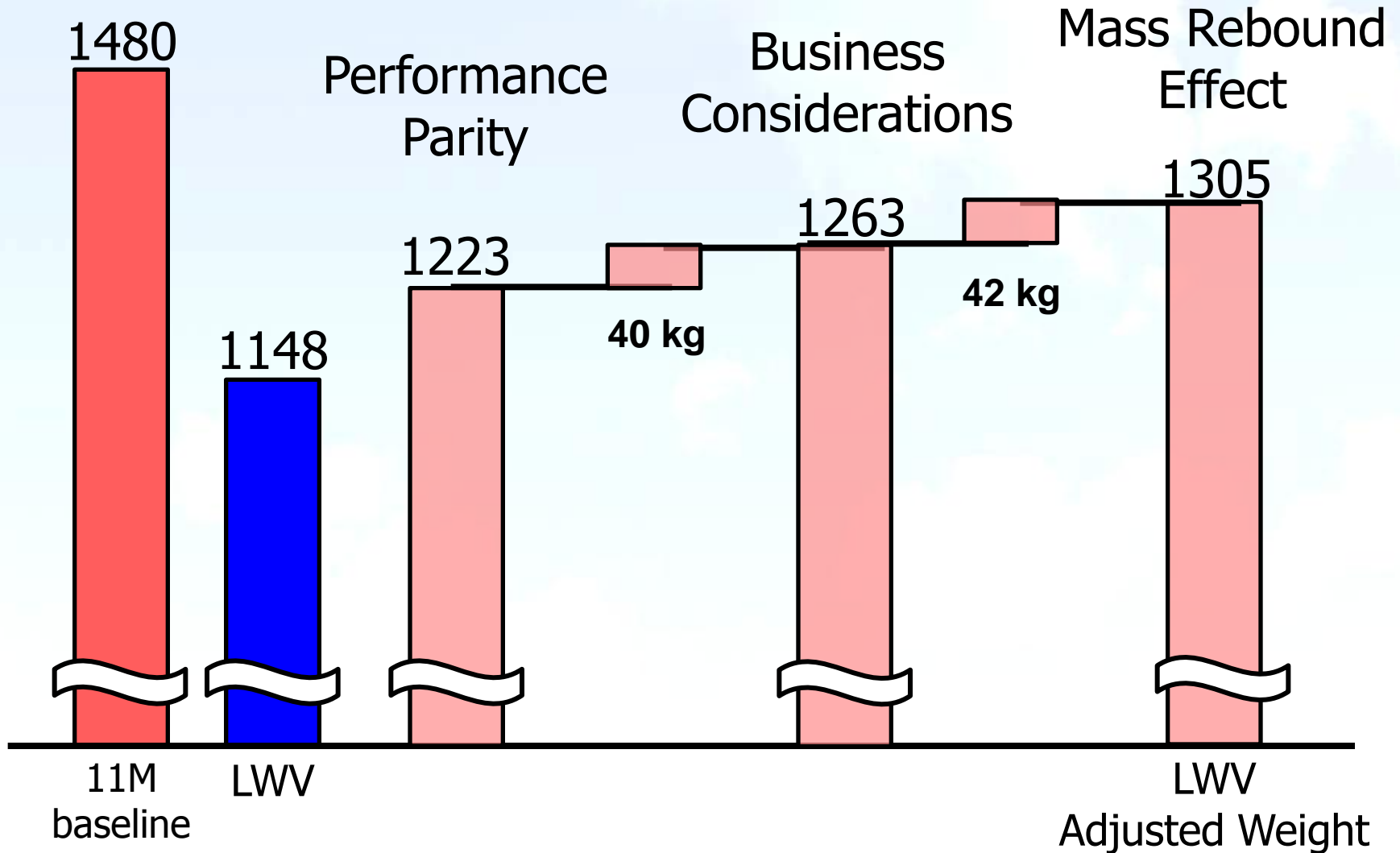
⑤ Necessary HP = 160HP → +30kg
 ✓ Displacement adjustment or turbo charging
 ✓ Transmission torque up

		LWV proposal	LWV adjusted	Rebound
Vehicle wt (mass reduction)		1148(▲332)	1306(▲174)	
Downsize items Mass reduction	PT	56.5	26.5	30
	other systems	33.5	21.5	12
	total	90	48	42

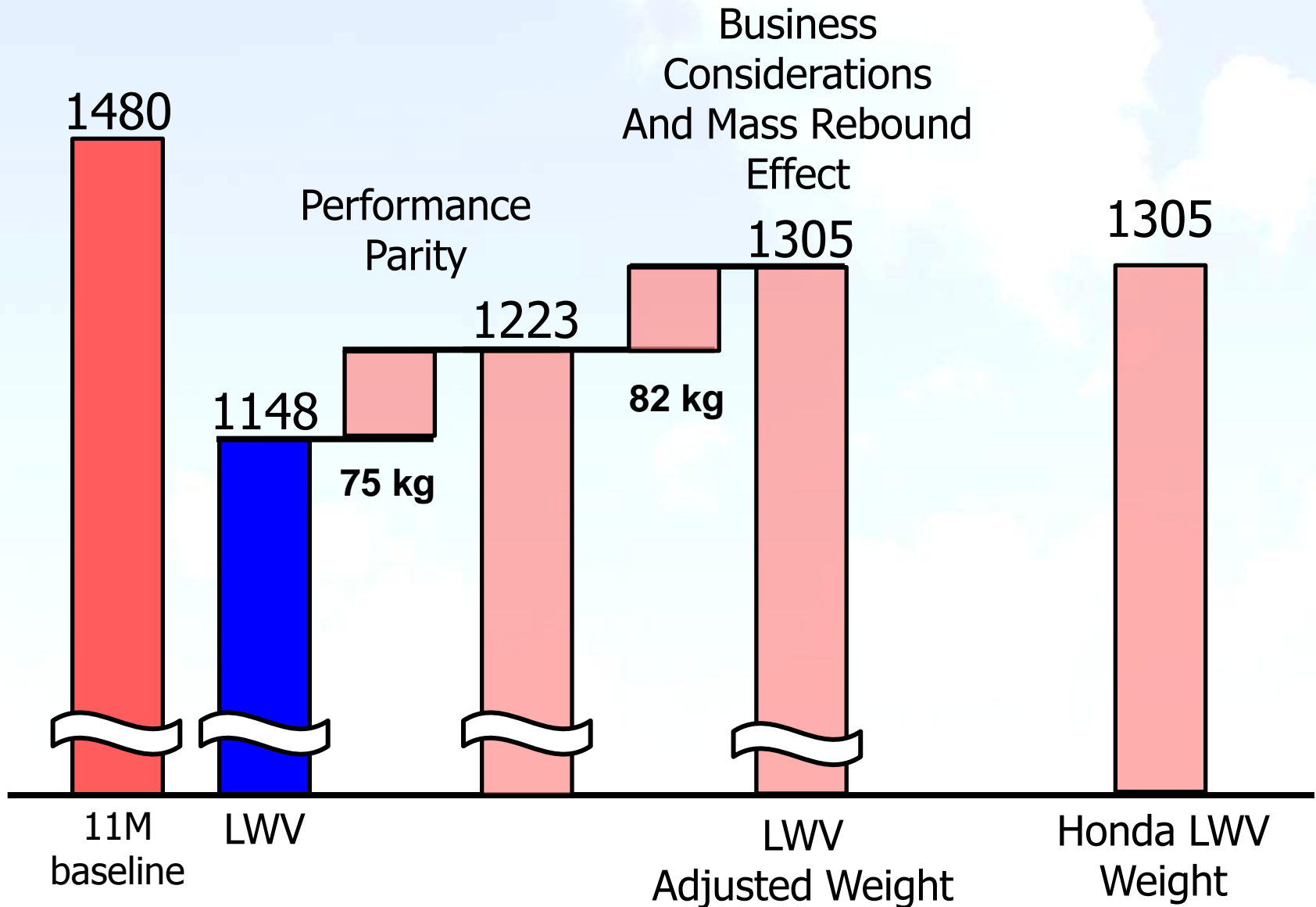
⑥

Available downsize items are ▲48kg(+42kg).

LWV Weight Adjustments : 82 Kg



LWV Weight Total Adjustments : 157 Kg



units: kg

Conclusion

- In order to achieve true performance parity with the 2011 Accord several adjustments to the LWV are needed:
 - Crashworthiness, Drivability, NVH Performance, and Others.
- Considering performance and business issues impact on weight, the true achievement of the LWV scenario is closer to 175 kg reduction not the 332 kg reduction predicted in the report.
- In addition manufactures must consider increasing demands for performance in upcoming design cycles (Safety, drivability, etc.) These factors over the two lifecycle timeline of the LWV were not considered.
 - These factors will impact the amount of achievable mass reduction over this period.
- Honda recognizes many of the technologies highlighted in the EDAG report have excellent weight reduction potential and Honda is already moving aggressively to introduce these materials and design ideas into our vehicles.
 - AHSS, Hot-Stamped Steels, Aluminum body and chassis parts, cast magnesium structures, reinforced plastics and composites, and other weight reduction technologies.

End