Informal Group on GTR9 Phase2 (IG GTR9-PH2) 5th Meeting

– Benefit and Cost -

Additional Analysis based on GTR9-2-07r1

December 6-7, 2012

Japan Automobile Standards Internationalization Center (JASIC)

Outline

1. Background
2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation
3. Vehicle Countermeasure Cost
4. Summary

1. Background

- At the 2nd IG GTR9-PH2 meeting, JASIC submitted a document (GTR9-2-07r1) with regard to a bendfit analysis as for Flex-PLI introduction to GTR9 Phase 2.
- However, Alliance was concerned about the following points:
  - ✓ Did not consider vehicle speed effect.
  - ✓ Should not include number of tibia fracture in fatalities.
- JASIC therefore conducted additional analysis to address their concerns.
- Moreover, JASIC obtained information for vehicle countermeasure cost due to introduction of GTR9 Phase 2 (relative to GTR9 Phase 1) from JAMA.
- Therefore, JASIC would like to share the cost information with this IG GTR9-PH2 members.

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

- In this analysis, we considered
  - ✓ Vehicle speed effect.
  - ✓ Exclude number of tibia fracture in fatalities.
- To consider vehicle speed effect,
  - Estimated tibia fracture number for each impact speed range based on national traffic accident data of Japan.
  - Calculated current Tibia fracture risk for each impact speed range.
  - Estimated tibia fracture risk when after the GTR9-PH2 is introduced for each impact speed range using CAE analysis.
- In the analysis, we excluded number of tibia fracture in fatalities.

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

Japan National Traffic Accident Data Year: 2004-2008 (5 years), Age: 16 years old +, Main injured part: Lower Extremity						Estimated from CAE	Estimated Results	
Travel Speed	Impact Speed (1)	Serious Lower Extremity Injury Number	Serious Tibia Injury Number (2)	Minor Lower Extremity Injury Number	Serious Tibia Injury Ratio (3)	Serious Tibia Injury Ratio after GTR9-Phase2 Introduction	Serious Tibia Injury Reduction Ratio (4)	Serious Tibia Injury Reduction Number (5)
(km/h)	(km/h)	(person)	(person)	(person)	(persentage)	(persentage)	(persentage)	(person)
0-20	5	4,478	2,955	27,190	9.3%	0.3%	9.1%	2,870
21-30	20	1,100	726	2,580	19.7%	4.5%	15.2%	560
31-40	30	1,372	906	1,695	29.5%	14.9%	14.6%	449
41-50	40	927	612	731	36.9%	29.2%	7.7%	128
51-60	50	355	234	224	40.5%	36.6%	3.9%	22
61-70	60	82	54	47	42.0%	50.6%	No analysis	0
71-80	70	21	14	10	44.7%	72.3%	No analysis	0
81-90	80	4	3	4	33.0%	89.3%	No analysis	0
91 and over	90 and over	10	7	8	36.7%	99.4%	No analysis	0
		total	5,510				total	4,029
							total (per year)	**806**

(1) Impact Speed = Travel Speed - 5 km/h
(2) Serious Tibia Injury Number = Serious Lower Extremity Injuriy Number x 66%
(3) Serious Tibia Injury Ratio = Serrious Tibia Injuries Number / (Serious Lower Extremity Injury Number + Minor Lower Extremity Injury Number)
(4) Serious Tibia Injury Reduction Ratio = Serrious Tibia Injury Ratio - Serious Tibia Injury Ratio after GTR9-Phase2 Introduction
(5) Serious Tibia Injury Reduction Number = Serrious Tibia Injury Reduction Ratio x (Serious Lower Extremity Injury Number + Minor Lower Extremity Injury Number)

Japan National Traffic Accident Data was provided by NASVA

- We obtained Japan National Traffic Accident Data in Japan which was provided by NASVA.
- The data characteristics are as follows:
  - ✓ Year: 2004-2008 (5 years)
  - ✓ Age: 16 years old and older
  - ✓ Most severely injured body region: Lower Extremity

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

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Japan National Traffic Accident Data was provided by NASVA

- The Japan National Traffic Accident Data only contain "Travel Speed" of car, we therefore converted the median "Travel Speed" to representative "Impact Speed" based on Japan Regional Traffic Accident Data analysis (see Appendix 1).
- An equation for the conversion is as follows:
  - ✓ Impact Speed = Travel Speed - 5 km/h

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

Japan National Traffic Accident Data Year: 2004-2008 (5 years), Age: 16 years old +, Main injured part: Lower Extremity						Estimated from CAE	Estimated Results	
Travel Speed	Impact Speed (1)	Serious Lower Extremity Injury Number	Serious Tibia Injury Number (2)	Minor Lower Extremity Injury Number	Serious Tibia Injury Ratio (3)	Serious Tibia Injury Ratio after GTR9-Phase2 Introduction	Serious Tibia Injury Reduction Ratio (4)	Serious Tibia Injury Reduction Number (5)
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Japan National Traffic Accident Data was provided by NASVA

- The Japan National Traffic Accident Data only contain "Serious Lower Extremity Injury Number", i.e. no information for "Serious Tibia Injury Number".
- We therefore converted the "Serious Lower Extremity Injury Number" to "Serious Tibia Injury Number" using Japan Regional Traffic Accident Data analysis results (see Appendix 2).
- An equation for the conversion is as follows:
  - ✓ "Serious Tibia Injury Number" = "Serious Lower Extremity Injury Number" x 66%

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Japan National Traffic Accident Data was provided by NASVA

- "Serious Tibia Injury Ratio" under Japan national traffic accident situation was calculated using the following equation:
  - ✓ "Serious Tibia Injury Ratio" = "Serious Tibia Injury Number" / ("Serious Lower Extremity Injury Number" + "Minor Lower Extremity Injury Number")

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Japan National Traffic Accident Data was provided by NASVA

- "Serious Tibia Injury Ratio after GTR9 Phase 2 Introduction" was estimated using CAE analysis results (see Appendix 3).
- Above table shows estimated "Serious Tibia Injury Ratio after GTR9 Phase 2 Introduction" for each impact speed range.

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Japan National Traffic Accident Data was provided by NASVA

- "Serious Tibia Injury Reduction Ratio" was calculated based on following equation:
  - ✓ "Serious Tibia Injury Reduction Ratio" = "Serious Tibia Injury Ratio" - "Serious Tibia Injury Reduction Ratio after GTR9 Phase 2 introduction"
- One remark for this analysis is that we did not conduct any analysis for travel speed above 60 km/h (impact speed above 55 kph).
- The Japan National Traffic Accident Data does NOT involve "Serious Lower Extremity Injury Number" for pedestrians who had more sever injury to other body regions. Especially at the high impact speed cases, pedestrian's "Head" tends to sustain more sever injury than “Lower Extremity". For this reason, we simply assumed no tibia fracture mitigation in this speed range.

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

Japan National Traffic Accident Data Year: 2004-2008 (5 years), Age: 16 years old +, Main injured part: Lower Extremity						Estimated from CAE	Estimated Results	
Travel Speed	Impact Speed (1)	Serious Lower Extremity Injury Number	Serious Tibia Injury Number (2)	Minor Lower Extremity Injury Number	Serious Tibia Injury Ratio (3)	Serious Tibia Injury Ratio after GTR9-Phase2 Introduction	Serious Tibia Injury Reduction Ratio (4)	Serious Tibia Injury Reduction Number (5)
(km/h)	(km/h)	(person)	(person)	(person)	(persentage)	(persentage)	(persentage)	(person)
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- "Serious Tibia Injury Reduction Number" was calculated using following equation:
  - ✓ "Serious Tibia Reduction Number" = "Serious Tibia Injury Reduction Ratio" x ("Serious Lower Extremity Injury Number" + "Minor Lower Extremity Injury Number")
- Finally, by dividing the number by 5 (5 years), then we obtained serious tibia injury reduction number for per year (806 persons).

2. Additional Analysis on Cost Reduction due to Tibia Fracture Mitigation

Severe Tibia Injury Reduction Number	Coverage Icrease by Introducing FlexPLI	Comprehensive Cost per Case					Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation
		Economic Test per Case				Intangible Consequences per Case*	
		Human Cost per Case	Property Cost per Case*	Company Cost per Case*	Public Agency Cost per Case*		
		$24,650	$6,407	$3,947	$32,828	$123,008	
(a)	(b)	(c)					(d)
806	82.5%	$190,840					**$126,876,499**

Coverage Increase relative to EEVC Legform Impactor: GTR9-2-07r1, slide 6
Comprehensive Cost per Case: GTR9-2-07r1, slide 23
Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation (d) = (a) x (b) x (c)
* US data was used.

- "Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation" was calculated using following equation:
  - ✓ "Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation" = "Severe Tibia Injury Reduction Number" x "Coverage Increase by Introduction FlexPLI" x "Comprehensive Cost per Case"
- "Coverage Increase by Introduction FlexPLI" and "Comprehensive Cost per Case" are based on GTR9-2-07r1 analysis results (slide 6 and slide 23, see Appendix 4 and 5).
- Finally, Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation became $126,876,499 in Japan.

3. Vehicle Countermeasure Cost

- In the NHTSA questions (GTR9-4-19), there was a question for the vehicle countermeasure cost to meet GTR9 requirements.
- JASIC obtained information on vehicle countermeasure cost due to introduction of GTR9 Phase 2 (relative to GTR9 Phase 1) from JAMA.
- Therefore, JASIC would like to share the cost information with this IG GTR9-PH2 members.

GTR9-

Overview of NHTSA Pedestrian Activities

Sept. 17-18, 2012

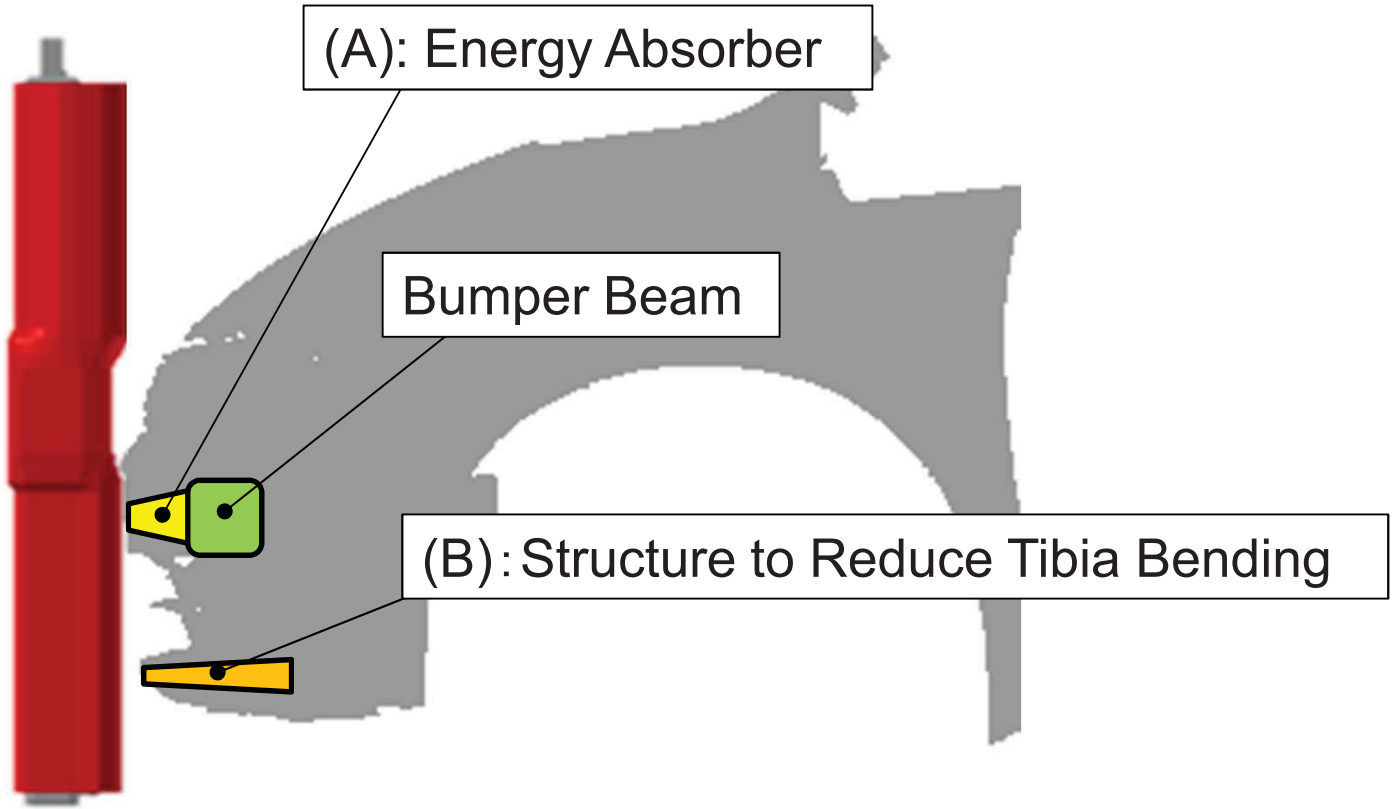
GTR9-4-19

GTR No. 9 Leg: Cost

Previous	Current	IWG Question
• Met individually with many OE's and suppliers • Obtained wide range of answers depending on who we asked • These costs were based on pre-PEDPRO designs	• Conducting independent teardown assessment • Seeking updated cost information from industry • PEDPRO built into many global platforms (constructing vehicle list for testing)	• How do other countries assess implementation costs to industry to make bumpers meet GTR No. 9? • Need cost differential of bumper part swaps for NA vs. global

3. Vehicle Countermeasure Cost

- The requirements for both Phase-1 (EEVC LFI) and Phase-2 (FlexPLI) legforms can be met by controlling the stiffness of the energy absorber in front of the bumper beam (A) and the stiffness of the lower part of the bumper (B)
- Same basic structure, similar cost
- In general, the stiffness of the lower part of the bumper (B) needs to be lowered compared to EEVC LFI to reduce tibia bending moment



4. Summary

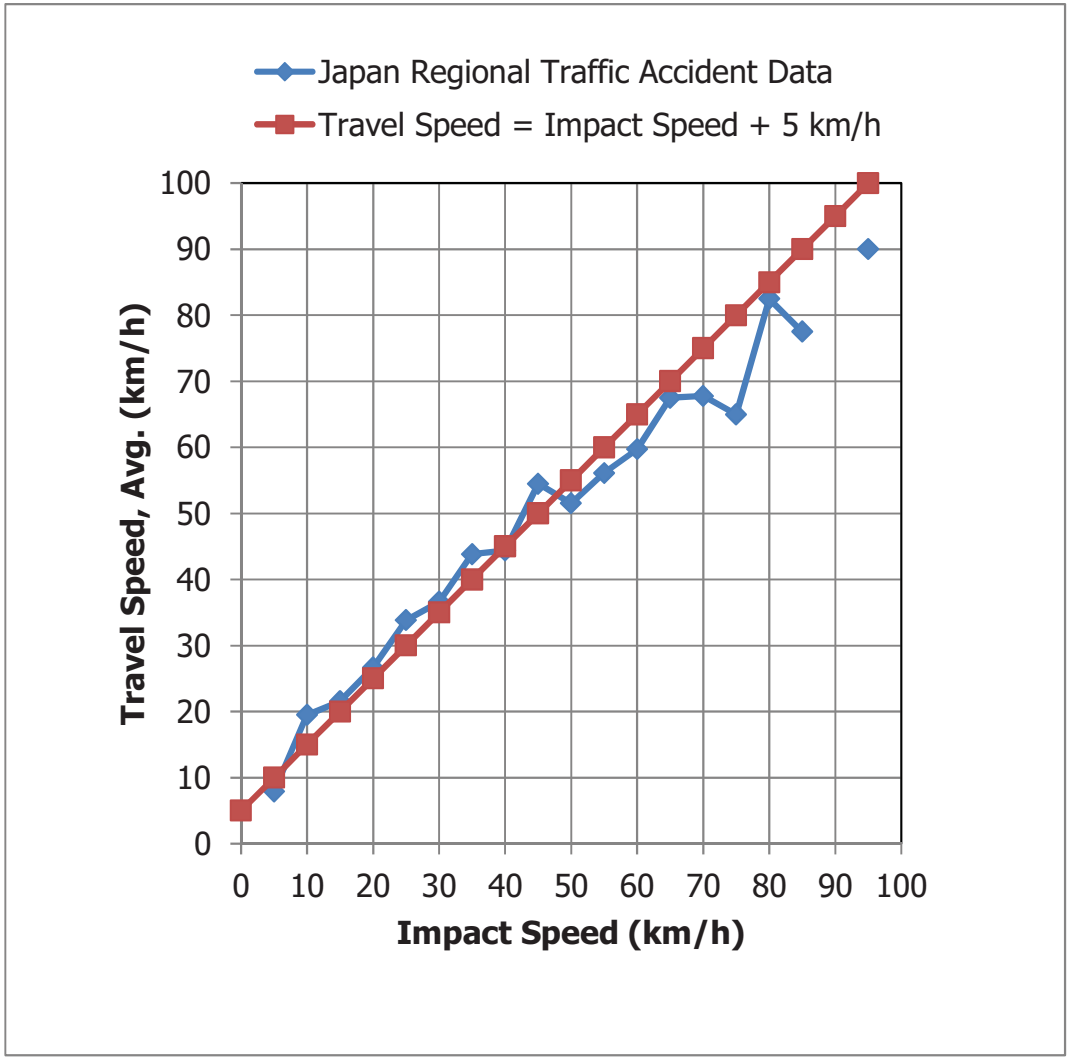
- In this analysis, "vehicle speed effect" as well as "exclusion of tibia fracture number in fatalities" were additionally considered for the JASIC Benefit Analysis (GTR9-2-07r1).

- As a result, it was found that Annual Comprehensive Cost Reduction from Tibia Fracture Mitigation became $126,876,499 in Japan.

- Regarding vehicle countermeasure cost due to introduction of GTR9 Phase 2 (relative to GTR9 Phase 1) , JAMA informed us that no significant difference regarding vehicle cost. (need to control the stiffness of the energy absorber in front of the bumper beam and the stiffness of the lower part of the bumper though)

Thank you for your attention

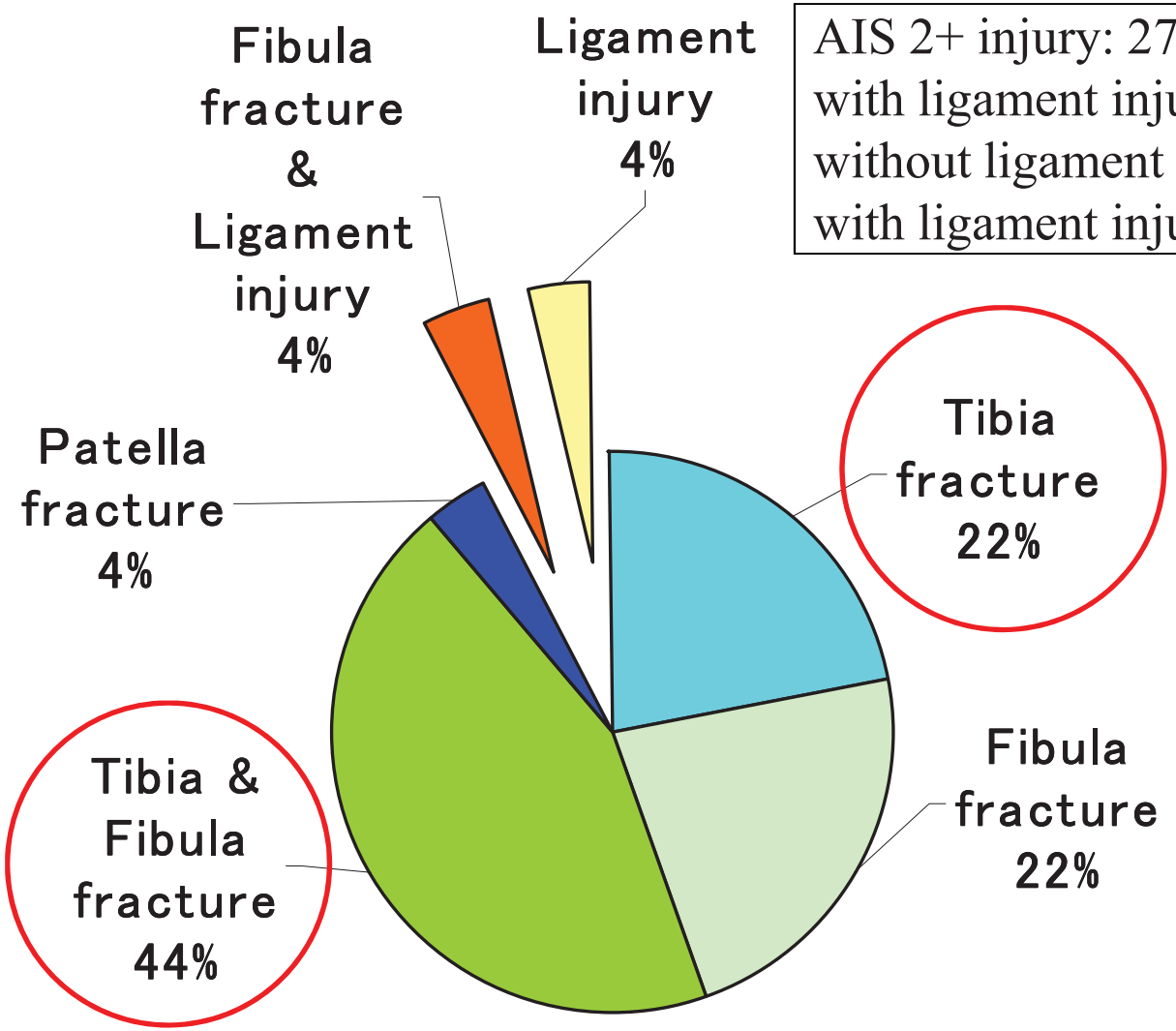
Appendix 1: Correlation between Travel Speed and Impact Speed



Japan Regional Traffic Accident Data was provided by NASVA

Appendix 2:
Lower Extremity Injury (ITARDA 2002, Japan)

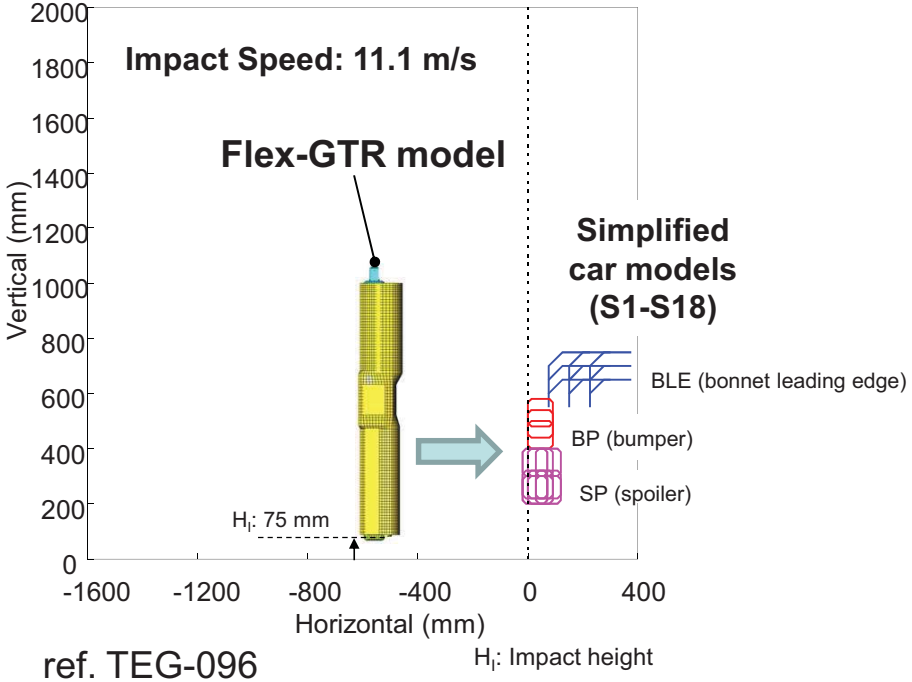
AIS 2+ injury: 27 out of 193 Accidents
with ligament injury : 8 %
without ligament injury : 92 %
with ligament injury and tibia fracture: 0 %



Appendix 3: Relationship between Impact Speed and Tibia Injury Ratio

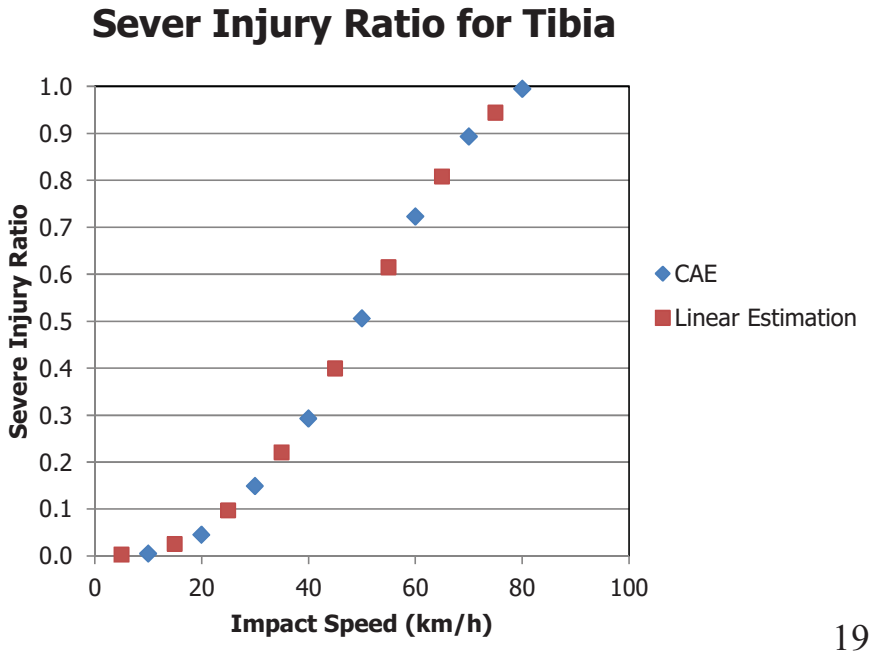
Impact Speed	Tibia Bending Moment Average of 18 Cases	Tibia Bending Moment Ratio compared to 40km/h impact situation	Estimated Tibia Bending Moment correspond to 340 Nm @ 40 km/h	Severe Injury Ratio for Tibia
(km/h)	(Nm)	(percentage)	(percentage)	(percentage)
10	104.2	37.7%	128.0	0.5%
20	177.6	64.2%	218.2	4.5%
30	235.2	85.0%	288.9	14.9%
40	276.8	100.0%	340.0	29.2%
50	320.8	115.9%	394.1	50.6%
60	362.5	131.0%	445.3	72.3%
70	404.9	146.3%	497.4	89.3%
80	477.8	172.6%	587.0	99.4%

ref. GTR9-1-06r1



ref. TEG-096

H: Impact height



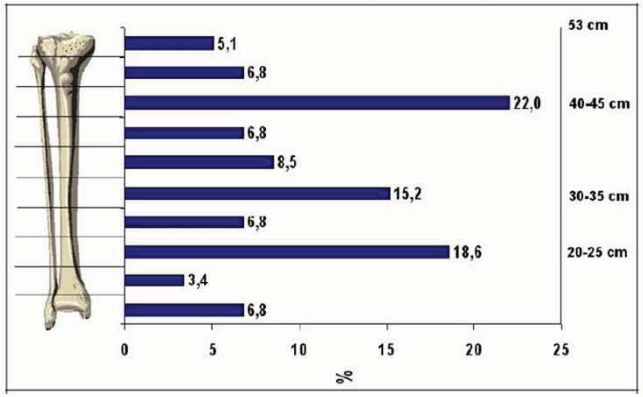
Appendix 4: Coverage Increase by Introduction FlexPLI

GTR9-2-07r1, Slide 6

1. Anticipated Factors for Enhanced Injury Mitigation

GTR9-1-07r1

- Otte et al. (2007) -



If the heights of the fractures are correlated to the effective dynamic heights of the bumpers, it turns out that 80% of all fractures are located between 19 and 46 cm, whereas 80% of the impact forces are transferred at heights of 32 to 44 cm of the lower leg (Figure 4). Thus the cause of the fractures is frequently located above the fracture itself. Fracture height and bumper height were only identical in 17.5% of the cases, in 47.5% fracture was above the bumper and 35% fracture below the bumper.

- Fracture location was identical to the bumper height only in 17.5 % of the cases
- 82.5% of fractures are presumed to be due to indirect loading

Reference: Otte, D., Haasper, C., Characteristics on Fractures of Tibia and Fibula in Car Impacts to Pedestrians – Influences of Car Bumper Height and Shape, IRCOBI Conference (2007)

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Coverage Increase by Introduction FlexPLI

Appendix 5: Comprehensive Cost per Case

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2. Estimation of Cost Reduction due to Tibia Fracture Mitigation

- Cost per Case Comparison -

		Economic Cost				Intangible Consequences	Comprehensive Cost
		Human Cost	Property Cost	Company Cost	Public Agency Cost		
Definition		• Medical Cost • Market Productivity • Household Productivity	• Property Damage	• Workplace Costs	• Emergency Services • Insurance Administration • Legal Costs • Travel Delay	• QALYs	• Sum of Economic Cost and Intangible Consequence
Cost	US	$126,464	$6,407	$3,947	$32,828	$123,008	$292,654
	JPN	$24,650	N/A	N/A	N/A	N/A	N/A

QALY : Quality-Adjusted Life Years lost

Total: Comprehensive Cost per Case in JPN
(US data was used if JPN data does not exist)

Breakdown of Human Cost

	Human Cost		
	Medical Cost	Market Productivity	Household Productivity
US	$42,237	$65,049	$19,178
JPN	$24,650		

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