FlexPLI Repeatability in Car Tests

Action List Item 1. i)
Evaluation of reproducibility and repeatability

5th IG GTR9-PH2 Meeting
6-7/December/2012
Japan Automobile Manufacturers Association (JAMA)
Pedestrian Safety Experts Group
Overview of NHTSA Pedestrian Activities
Sept. 17-18, 2012

FlexPLI: Repeatability

<table>
<thead>
<tr>
<th>Previous</th>
<th>Current</th>
<th>IWG Question</th>
</tr>
</thead>
<tbody>
<tr>
<td>• FlexPLI was demonstrated to provide very repeatable results in limited repeated vehicle testing</td>
<td>• Conduct multiple tests to same location with our FlexPLI</td>
<td>• Have any labs examined Flex repeatability in vehicle bumper impacts?</td>
</tr>
</tbody>
</table>
FlexPLI Car Tests by JAMA Members

- Car tests using FlexPLI mass production model
- Tests against 3 vehicles
- Car A: 2 repeated tests, 2 test points
- Car B: 2 repeated tests, 1 test point
- Car C: 3 repeated tests, 1 test point
- 3 tests with Car C include symmetric test points (2 tests on right side and 1 test on left side)
Test Results

GTR9-5-11
Car A, Test Point 2

Tibia

Knee Ligament

Bending Moment (Nm)

Elongation (mm)

Car A, Test Point 2

Tibia1

Tibia2

Tibia3

Tibia4

MCL

ACL

PCL

N=1

N=2
Test Results

Car B, Test Point 1

Tibia

Knee Ligament

GTR9-5-11

Bending Moment (Nm)

Elongation (mm)

Tibia1

Tibia2

Tibia3

Tibia4

MCL

ACL

PCL

N=1

N=2

N=1

N=2

N=1

N=2

N=1

N=2

N=1

N=2

N=1

N=2
Test Results

GTR9-5-11
Car C, Test Point 1

Tibia

Knee Ligament

MCL

ACL

PCL
Evaluation of Test Results

1. Comparison of Time Histories (Car A – C)
   Good repeatability confirmed

2. Evaluation of Coefficient of Variation (Car C)

Peak Injury Measures and CV Values

<table>
<thead>
<tr>
<th></th>
<th>Tibia-1 (Nm)</th>
<th>Tibia-2 (Nm)</th>
<th>Tibia-3 (Nm)</th>
<th>Tibia-4 (Nm)</th>
<th>Knee-ACL (mm)</th>
<th>Knee-PCL (mm)</th>
<th>Knee-MCL (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>N=1</td>
<td>184</td>
<td>193</td>
<td>197</td>
<td>191</td>
<td>5.7</td>
<td>4.6</td>
<td>17.7</td>
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<tr>
<td>N=2</td>
<td>184</td>
<td>193</td>
<td>197</td>
<td>191</td>
<td>5.3</td>
<td>4.6</td>
<td>17.4</td>
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<tr>
<td>N=3</td>
<td>184</td>
<td>193</td>
<td>197</td>
<td>191</td>
<td>5.3</td>
<td>4.6</td>
<td>17.4</td>
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<tr>
<td>Avg.</td>
<td>184</td>
<td>193</td>
<td>197</td>
<td>191</td>
<td>5.3</td>
<td>4.6</td>
<td>17.4</td>
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<tr>
<td>St. Dev.</td>
<td>6</td>
<td>7</td>
<td>10</td>
<td>3</td>
<td>0.3</td>
<td>0.1</td>
<td>0.2</td>
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<tr>
<td>CV (%)</td>
<td>3.0</td>
<td>3.9</td>
<td>6.1</td>
<td>1.7</td>
<td>5.3</td>
<td>3.2</td>
<td>1.1</td>
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<tr>
<td>Standard value</td>
<td>340</td>
<td>340</td>
<td>340</td>
<td>340</td>
<td>13</td>
<td>13</td>
<td>22</td>
</tr>
<tr>
<td>Standard value/St. Dev.(%)</td>
<td>1.7</td>
<td>2.2</td>
<td>3.1</td>
<td>1.0</td>
<td>2.3</td>
<td>1.3</td>
<td>0.9</td>
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</table>

Distribution of CV Values

<table>
<thead>
<tr>
<th></th>
<th>Good</th>
<th>Acceptable</th>
<th>Marginal</th>
</tr>
</thead>
<tbody>
<tr>
<td>CV</td>
<td>2</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>29%</td>
<td>71%</td>
<td>0</td>
</tr>
<tr>
<td>Standard value/St. Dev.</td>
<td>6</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td>86%</td>
<td>14%</td>
<td>0</td>
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</tbody>
</table>

Judgements

- Good: < 3%
- Acceptable: 3% ≤ and < 7%
- Marginal: 7% ≤ and < 10%
- Not Acceptable: > 10%

Rating scheme taken from Flex-TEG Document (TEG-105)

All measures fell within Good or Acceptable (CV less than 7%) in Car Tests