2010 Toyota Yaris

FE Model

The National Crash Analysis Center
The George Washington University
Model Information

<table>
<thead>
<tr>
<th>Description</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of Parts</td>
<td>771</td>
</tr>
<tr>
<td>Number of Nodes</td>
<td>998,218</td>
</tr>
<tr>
<td>Number of Shells</td>
<td>950,560</td>
</tr>
<tr>
<td>Number of Beams</td>
<td>4,497</td>
</tr>
<tr>
<td>Number of Solids</td>
<td>19,314</td>
</tr>
<tr>
<td>Total Number of Elements</td>
<td>974,383</td>
</tr>
</tbody>
</table>
Connections

- BEAM CONNECTIONS  4324
- NODAL_RIGID_BODY  423
- EXTRA_NODES_SET  16
- JOINTS  14
- RIGID_BODIES  2
- SPOTWELD  2862
Material Testing

- Specimens were cut from actual components
- 160 tensile tests
- Data converted
- 12 different materials generated based on test data
Accelerometers

- Left Rear Seat (Node 4000390)
- Right Rear Seat (Node 4000398)
- Engine Top (Node 4000414)
- Engine Bottom (Node 4000422)
- Vehicle C.G. (Node 4000406)
# Inertia Comparisons

<table>
<thead>
<tr>
<th></th>
<th>Actual Vehicle</th>
<th>FE Model</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight, kg</td>
<td>1078</td>
<td>1100</td>
</tr>
<tr>
<td>Pitch inertia, kg-m^2</td>
<td>1498</td>
<td>1566</td>
</tr>
<tr>
<td>Yaw inertia, kg-m^2</td>
<td>1647</td>
<td>1739</td>
</tr>
<tr>
<td>Roll inertia, kg-m^2</td>
<td>388</td>
<td>395</td>
</tr>
<tr>
<td>Vehicle CG X, mm</td>
<td>1022</td>
<td>1004</td>
</tr>
<tr>
<td>Vehicle CG Y, mm</td>
<td>-8.3</td>
<td>-4.4</td>
</tr>
<tr>
<td>Vehicle CG Z, mm</td>
<td>558</td>
<td>569</td>
</tr>
</tbody>
</table>
## Full-Scale Crash Tests

> **Toyota Yaris (2006-2010)**

<table>
<thead>
<tr>
<th>Test Type</th>
<th>Test Number</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frontal Full Wall</td>
<td>NHTSA 5677 (56.3 km/hr), 6221 (56.2 km/hr), 6059 (39.8 km/hr), 6060 (39.8 km/hr), 6069 (39.8 km/hr)</td>
</tr>
<tr>
<td>Frontal Offset</td>
<td>IIHS CEF0610 (64.7 km/hr)</td>
</tr>
<tr>
<td>Side Impact NHTSA</td>
<td>NHTSA 5679 (62.1 km/hr), 6220 (62.3 km/hr), 6558 (61.9 km/h), 6585 (61.8 km/hr)</td>
</tr>
<tr>
<td>Roof Strength</td>
<td>IIHS SWR0920</td>
</tr>
<tr>
<td>Side Impact IIHS</td>
<td>IIHS CES50638 (50.2 km/hr), CES0639 (50.0 km/hr)</td>
</tr>
</tbody>
</table>
Yaris – Frontal Full Wall – 56 km/hr

- Two Full-scale Crash Tests @ 56 km/hr:
  - NHTSA 5677 (56.3 km/hr) – 2007 Sedan
  - NHTSA 6221 (56.2 km/hr) – 2008 Hatch Back
Yaris – Frontal Full Wall – 56 km/hr

<table>
<thead>
<tr>
<th></th>
<th>FE Model</th>
<th>Test 5677</th>
<th>Test 6221</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>1263</td>
<td>1271</td>
<td>1245</td>
</tr>
<tr>
<td>Engine Type</td>
<td>1.5L V4</td>
<td>1.5L V4</td>
<td>1.5L V4</td>
</tr>
<tr>
<td>Tire size</td>
<td>P185/60R15</td>
<td>P185/60R15</td>
<td>P185/60R15</td>
</tr>
<tr>
<td>Attitude (mm) (As delivered)</td>
<td>F – 668</td>
<td>F – 673</td>
<td>F – 675</td>
</tr>
<tr>
<td></td>
<td>R – 673</td>
<td>R – 680</td>
<td>R – 673</td>
</tr>
<tr>
<td>Wheelbase (mm)</td>
<td>2538</td>
<td>2551</td>
<td>2463</td>
</tr>
<tr>
<td>CG (mm) Rear of front wheel C/L</td>
<td>1035</td>
<td>999</td>
<td>976</td>
</tr>
<tr>
<td>Body Style</td>
<td>4 Door Sedan</td>
<td>4 Door Sedan</td>
<td>3 Door Liftback</td>
</tr>
</tbody>
</table>

LS-DYNA:
- Version: MPP971sR4.2.1
- Revision: 53450
- Platform: Intel MPI 3.1 Xeon64
- OS Level: Linux Red Hat 4 upd 4
- Precision: Single precision (I4R4)
- Total elapsed time: 2 hr 15 min (150 ms)
- Number of processors: 24
Yaris – Frontal Full Wall – 56 km/hr

Component:
- A. Kinetic Energy
- B. Internal Energy
- C. Total Energy
- D. Hourglass Energy
- E. Sliding Energy

Energy (N/mm²(E-h)) vs. Time (s)
Yaris – Frontal Full Wall – 56 km/hr
Yaris – Frontal Full Wall – 56 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons

Comparison Metric values
Whole time interval [0.0, 0.1489]

MPC Metrics
- Sprague Goals Magnitude: 27 Pass
- Sprague Goals Phase: 0.4 Pass

ANOVA Metrics
- Average: G1 Pass
- Standard deviation: 10.1 Pass

Acceleration Residuals
- Residual time history
- Residuals histogram
- Residuals cumulative distribution
Yaris – Frontal Full Wall – 56 km/hr
Yaris – Frontal Full Wall – 56 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Full Wall – 56 km/hr
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Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Full Wall – 56 km/hr
Yaris – Frontal Full Wall – 56 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Offset – 64 km/hr
Yaris – Frontal Offset – 64 km/hr

Vehicle Center of Gravity

Acceleration (g)

Time (s)

Vehicle Center of Gravity

Velocity (km/hr)

Time (s)
Yaris – Frontal Offset – 64 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Full Wall – 40 km/hr

<table>
<thead>
<tr>
<th></th>
<th>FE Model</th>
<th>Test 6069</th>
</tr>
</thead>
<tbody>
<tr>
<td>Weight (kg)</td>
<td>1211</td>
<td>1212</td>
</tr>
<tr>
<td>Engine Type</td>
<td>1.5L V4</td>
<td>1.5L V4</td>
</tr>
<tr>
<td>Tire size</td>
<td>P185/60R15</td>
<td>P185/60R15</td>
</tr>
<tr>
<td>Attitude (mm)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(As delivered)</td>
<td>F – 668</td>
<td>F – 673</td>
</tr>
<tr>
<td></td>
<td>R – 673</td>
<td>R – 672</td>
</tr>
<tr>
<td>Wheelbase (mm)</td>
<td>2538</td>
<td>2550</td>
</tr>
<tr>
<td>Body Style</td>
<td>4 Door Sedan</td>
<td>4 Door Sedan</td>
</tr>
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Yaris – Frontal Full Wall – 40 km/hr
Yaris – Frontal Full Wall – 40 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Full Wall – 40 km/hr
Yaris – Frontal Full Wall – 40 km/hr

Comparison Metric values
Whole time interval [0, 0.1499]

MPC Metrics

- Spring-Goer Magnitude
  - Value [%]: 4.5
  - Pass

- Spring-Goer Phase
  - Value [%]: 12.4
  - Pass

ANOVA Metrics

- Average
  - Value [%]: -0.4
  - Pass

- Standard deviation
  - Value [%]: 13.5
  - Pass

(Values normalized to peak of true curve)

Roadside Safety Verification and Validation Program (RSVVP) Comparisons

NCAC
Yaris – Frontal Full Wall – 40 km/hr

![Graph showing engine top and bottom acceleration](image-url)
Yaris – Frontal Full Wall – 40 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Yaris – Frontal Full Wall – 40 km/hr
Yaris – Frontal Full Wall – 40 km/hr

Roadside Safety Verification and Validation Program (RSVVP) Comparisons
Summary

- Model verified against 56 km/hr full frontal tests (NHTSA tests 5677 and 6221)
- Model verified against 64 km/hr frontal offset test (IIHS test CEF0610)
- Model verified against 40 km/hr full frontal test (NHTSA test 6069)
- Detailed suspension systems included in the model, verification using full-scale tests is in progress
- Future updates will include additional verifications, using NHTSA side, IIHS side, roof strength, and rigid pole tests