Topology Optimization of a Prototype Race Car Rear Wing Pillar

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Altair
6th European Altair Technology Conference
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Turin Italy

HyperWorks

http://www.lotus-lmp2.com
Advanced Design and Engineering Systems Solutions

Neue Balan campus
Munich, Germany

Formula 1 and Le Mans Prototype experience

Design

Computational Fluid Dynamics (CFD)

Finite Element Analysis (FEA)

Wind tunnel testing

Introduction
Introduction

- New Le Mans Prototype: Lotus T128 LMP2
- Regulations 2014 compliant
- 2013 World Endurance Championship (WEC)
- 2 cars sold
- LPM1 concept under consideration
Problem definition

- Rear wing pillar

- Specifications:
  - Structural aluminium alloy
  - Yield strength ($S_y$) = 280MPa
  - 15mm thick plate
  - 1000mmx350mm
  - 8.1kg

- Problem: excessive mass of the rear structure of the car

- Potential mass savings in rear wing pillar

- Aim of the study: minimise the mass of the rear wing pillar while sustaining aerodynamic load and complying with FIA (Fédération Internationale de L'Automobile) regulations
Problem definition

- Load cases:
  - Rear wing pillar initial design with rear wing assembly

1. Aerodynamic forces
   - Maximum speed in straight line
   - Vertical static load

2. FIA regulations
Analysis

- Optimization Constraints:

<table>
<thead>
<tr>
<th>Load case</th>
<th>Stress</th>
<th>Displacement</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Sy</td>
<td>-</td>
</tr>
<tr>
<td>2</td>
<td>Sy</td>
<td>10 mm (z)</td>
</tr>
</tbody>
</table>

- Optimization process:

→ optimization from closed volume necessarily means reduction in stiffness!
Results

- Final result
  - Element density plot
  - Initial rear wing pillar
  - Manufactured rear wing pillar
  - 8.1kg
  - 3.7kg
  - -54% mass
  - 1.10mm/kg
  - 0.36mm/kg
  - +205% Stiffness to mass ratio

2013 EATC Turin

Tuesday 23rd of April 2013
Conclusions

- Rear wing pillar reduction in mass
- Part behaviour understanding
- Rear structure mass target
Thank you