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FSAE Rear Differential Carrier

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FSAE Rear Differential Carrier

**Design**
- 1/4" 4130 alloy steel chosen because it was in stock
- Design to incorporate turnbuckle tensioners to adjust chain
- Bearing selected to meet size and performance parameters
- Double-sealed needle bearing to keep oil from leaking out of the differential
- 5mil nickel sleeves between all bearing surfaces to prevent steel-steel wear
- Chamfer bolt holes to eliminate stress concentrations
- Use grade 12.9 bolts on all assemblies for maximum reliability

**Analysis**
- Used finite element analysis to determine if design was sufficient
- Each plate was analyzed separately due to nodal constraints in ANSYS
- Assuming maximum acceleration of 2G and deceleration of 8G
- With 75/25 brake bias, 2G braking force on rear caliper
- Acceleration creates forces of approximately 13,500N
- Rounded to 15,000N to improve safety

Results of ANSYS analysis:

<table>
<thead>
<tr>
<th></th>
<th>Acceleration (Bearing load)</th>
<th>Braking:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peak stress</td>
<td>554.2 MPa</td>
<td>244.61 MPa</td>
</tr>
<tr>
<td>(Von Mises)</td>
<td>(without hole chamfer)</td>
<td></td>
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<td>Peak deformation</td>
<td>0.859 mm</td>
<td>0.116 mm</td>
</tr>
</tbody>
</table>

4130 alloy steel properties:
- Yield strength: 430 MPa
- Ultimate strength: 670 MPa

**Manufacturing**
- Bearing holders machined in-house using slab of 1018 alloy steel
- The rod was drilled for a 1" diameter then bored until specific bore was achieved
- Bore size confirmed frequently to ensure precise tolerances
- 8 holes drilled in bearing holder for assembly to carrier plates
- 4130 alloy plates outsourced to be waterjetted
- Plate holes chamfered by hand filing
- Diff housing internal splining removed with lathe to accommodate needle bearings

**Constraints & Successes**
- Minimal Factor of Safety – 2
- Bolt holes for Wil-120-5453 caliper
- Fit within the rear frame of the FSAE car
- Must last for 2 years per FSAE specifications

**Future Work?**
- Observe performance of carrier in race conditions
- Determine ideal locations to remove material to decrease weight
- Paint to inhibit corrosion and match car aesthetics

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Design Analysis Manufacturing

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