“Light weight, Low Cost, Composite Coil Springs are a Reality”

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SARDOU SA

1980-2005 : SARDOU SA Celebrates 25 years of innovation
www.sardou.net
A long history in SARDOU SA of highly stressed composite material structures

The First Laboratory Samples of Composite torsion beams tested in 1983

Torsion beam
60 mm diameter
600 mm long;
ultimate torque
280 000 N*meter
@ 60 ° of torsion
Up to 1992

C springs
tested successfully
up to 6 000 000 of
fatigue cycles
at high stress level
Up to 2002 first quarter
Composite Coil Springs: the revolution spring
Thanks to Composite Coil Springs, compared to standard metal coil springs, we get:

- Weight saving from 45% down to 25%
- Higher natural frequency
- Excellent NVH property
- No creep behaviour
- No notch sensitivity
- Failsafe design
- Corrosion free behaviour
- Non conductive material
- Composite TG 158 °C (316 Fahrenheit)
Composite Coil Springs Fatigue Testing

These results could be improved further with resin optimisation

<table>
<thead>
<tr>
<th>low cost resin type &amp; different curing cycles</th>
<th>jounce load capacity evolution</th>
<th>hysteresis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nb cycles done</td>
<td>Temperature (°C)</td>
<td>before test</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>1 025 147</td>
<td>60 000 cycles@100°C</td>
<td>91,1%</td>
</tr>
<tr>
<td>1 025 147</td>
<td>60 000 cycles@100°C</td>
<td>91,9%</td>
</tr>
<tr>
<td>1 025 147</td>
<td>60 000 cycles@100°C</td>
<td>95,1%</td>
</tr>
<tr>
<td>200 819</td>
<td></td>
<td>100,85%</td>
</tr>
<tr>
<td>200 819</td>
<td></td>
<td>101,19%</td>
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</table>
Composite Coil Springs strain gagging & thermal testing

<table>
<thead>
<tr>
<th>Nb cycles done</th>
<th>Temperature (°C)</th>
<th>Capacity evolution</th>
<th>Jounce load</th>
<th>Hysteresis</th>
</tr>
</thead>
<tbody>
<tr>
<td>123 668</td>
<td>60 000 cycles @ 125°C</td>
<td>91.5%</td>
<td>4.70%</td>
<td>2.30%</td>
</tr>
<tr>
<td>202 028</td>
<td></td>
<td>98.9%</td>
<td>3.20%</td>
<td>1.00%</td>
</tr>
</tbody>
</table>
Mass Production & Cost

- Composite raw material cost about 2 USD/Kg (E glass fibers & epoxy) (low cost epoxy solution)
- The continuous rope producing machine, where the fibers resin impregnation process is done, is self cleaning & numerically controlled.
- The maximum curing temperature is 160°C.
- Composite coils springs polymerization asks no more energy than a typical metal spring painting.
- The process use low energy, low price material & need just a few workers.

- **Mass production**
- **Composite Coil Springs cost**
- **can be below equivalent**
- **metal coils springs cost for much better performances & safety**

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**MASS PRODUCTION PROCESS**
- Use “on the shelf” technology:
  - A fully automated continuous rope producing machine
    - *(patented SARDOU SA)*
  - An automated coiling machine will wind the rope on lost cores
  - A maturation tunnel will be followed by a polymerization tunnel (lost core will be melted at the end of the polymerization)
  - After polymerization, removed from supporting gear, springs will be deburred measured & marked.

- **There is no bottle neck in the process.**
Conclusion

COMPOSITE COIL SPRINGS IS A VERY UNIQUE AND INNOVATIVE TECHNOLOGY

With Composite Coil Springs It is possible:

- To save money
- To save weight
- To improve CAFÉ ranking
- To achieve any shape
- To get offset on the trust of the spring (Mc Pherson)

Composite Coil Springs

- Can be fitted in place of standard metal coil springs in transportation industry.
- So a platform manager can chose to use composite coils spring in a fraction of its production and is able any time to stop or increase composite coils springs use.

Composite Coil Springs

- In general industry can be integrated in:
  - High speed mechanism. (high natural frequency)
  - Highly corrosive environment
  - Precision mechanism (no creep)
  - Pressure vessel using spring in place of gas
  - Parking brakes
  - Aeronautic or astronautic application (high energy storage to mass ratio)