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

Dr. Max A. Sardou

SARDOU SA

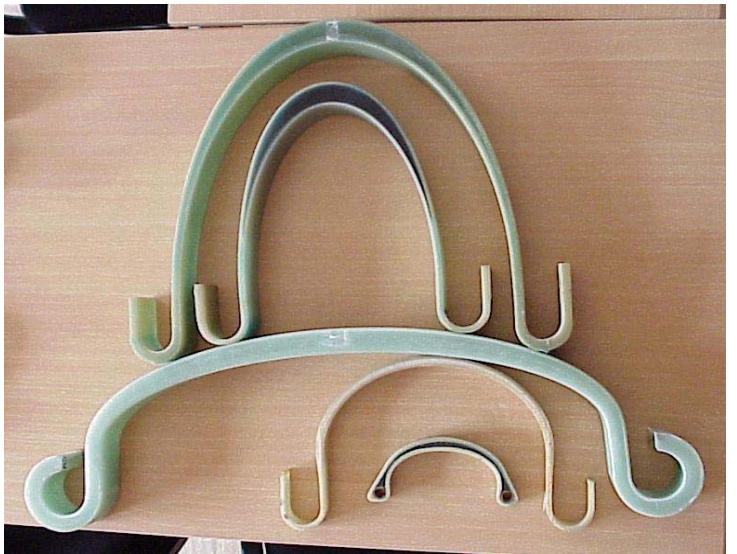
1980-2005 : SARDOU SA Celebrates 25 years of innovation

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

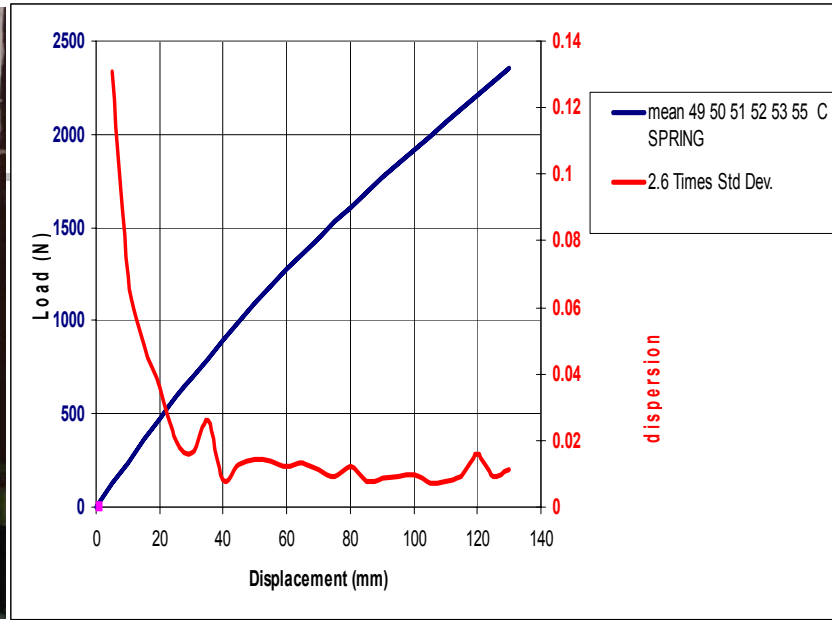
Torsion beam
60 mm diameter
600 mm long;
ultimate torque
280 000 N*meter
@ 60 ° of torsion
Up to 1992



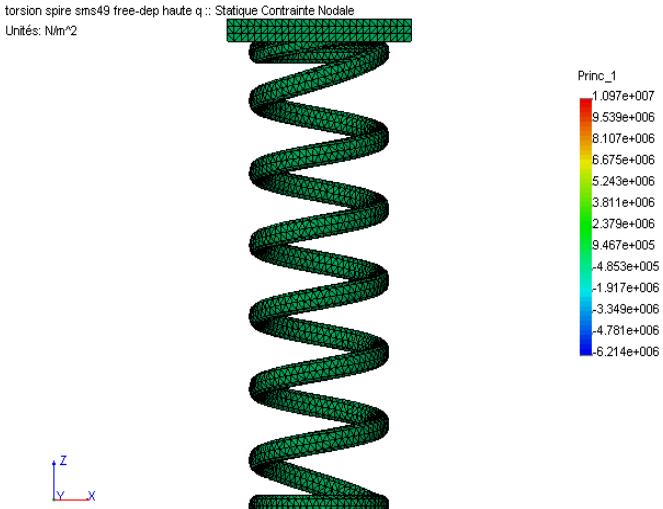
C springs
tested successfully
up to 6 000 000 of
fatigue cycles
at high stress level
Up to 2002 first quarter

Composite Coil Springs : the revolution spring

Composite Coil Springs Mechanical Properties



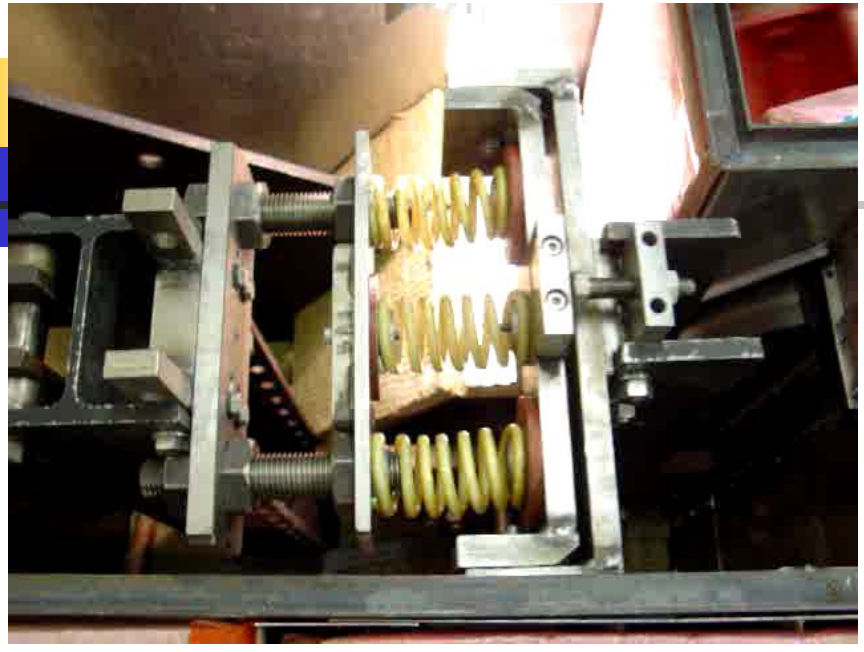
Thanks to Composite Coil Springs ,compared to standard metal coils springs, we get:

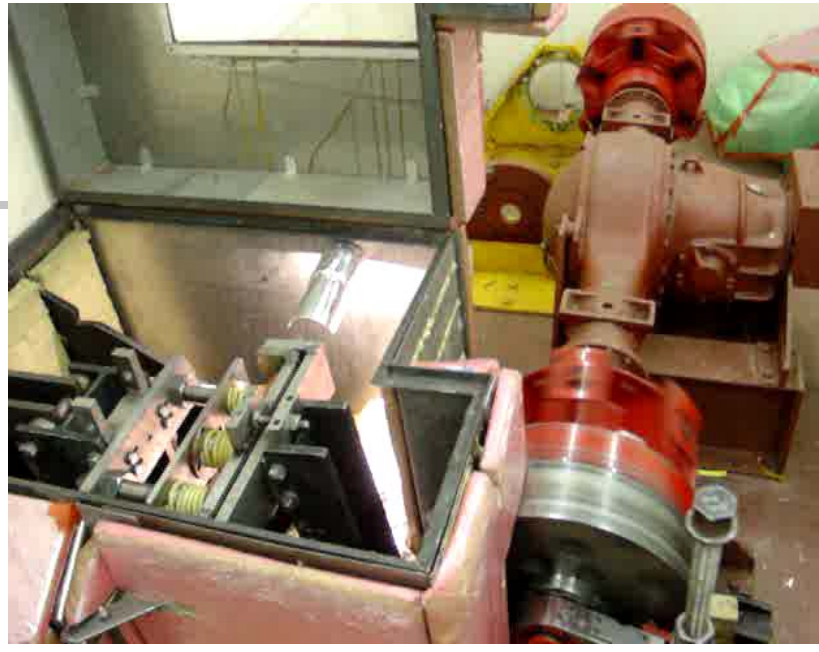


- Weight saving from 45 % down to 25 %
- Higher natural frequency
- Excellent NVH property
- No creep behaviour
- No notch sensitivity
- Failsafe design
- Corrosion free behaviour
- Non conductive material
- Composite TG 158 °C (316 Fahrenheit)

SAE 2005 WORLD CONGRESS

Composite Coil Springs Fatigue Testing





These results could be improved further with resin optimisation

low cost resin type & different curing cycles		jounce load capacity evolution	hysteresis		
Nb cycles done	Temperature (°C) 35		before test %	after test %	evolution %
1 025 147	60 000cycles@100°C	91,1%	2,80%	2,10%	-0,7%
1 025 147	60 000cycles@100°C	91,9%	4,90%	2,70%	-2,2%
1 025 147	60 000cycles@100°C	95,1%	2,60%	1,60%	-1,0%
200 819		100,85%	1,80%	1,90%	0,1%
200 819		101,19%	1,80%	2,20%	0,4%

Composite Coil Springs strain gagging & thermal testing

low cost resin type & different curing cycles		jounce load capacity evolution	hysteresis		
Nb cycles done	Temperature (°C) 105		before test	after test	evolution
			%	%	%
123 668	60 000cycles @ 125°C	91,5%	4,70%	2,30%	-2,4%
202 028		98,9%	3,20%	1,00%	-2,20%

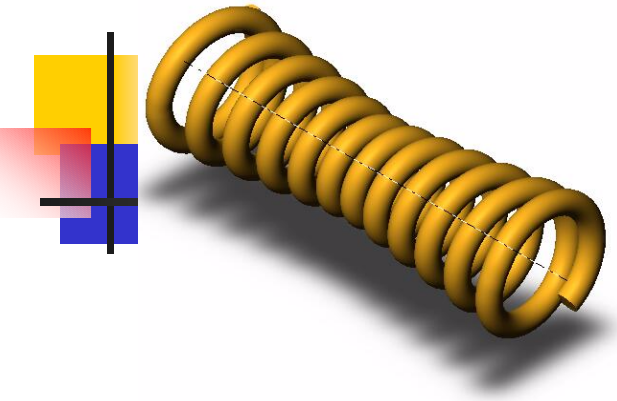
Mass Production & Cost

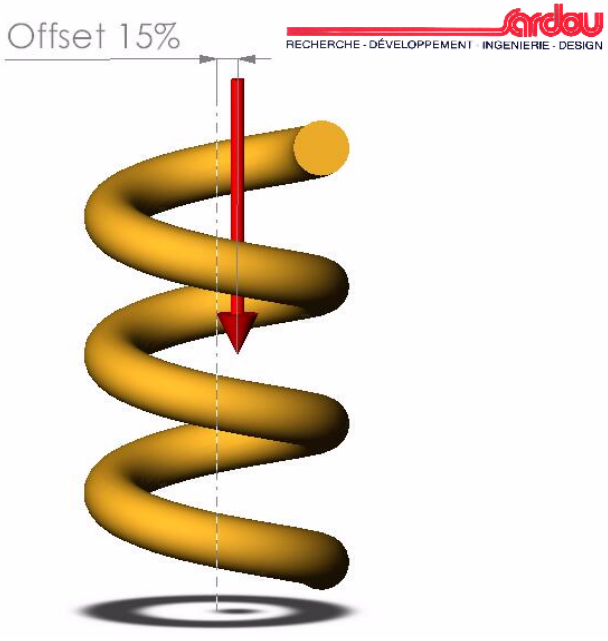
- **MASS PRODUCTION PROCESS**
- **use "on the shelf" technology:**
- **A fully automated continuous rope producing machine**

  (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.**

- **Composite raw material cost about 2 USD/Kg**
- **(E glass fibbers & 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**





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)