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# Formula 1 Composites Engineering

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ABSTRACT

Any engineering structure, irrespective of its intended purpose, must be made of one or more materials. More often than not it is the choice and behaviour of those materials that determine its mechanical performance. The introduction of fibre reinforced composite chassis was one of the most significant developments in the history of Grand Prix motor racing. Technological advances gained from these advanced materials have produced cars that are lighter, faster and safer than ever before. The manufacture of Formula 1 cars is now dominated by composites. A short introduction to the science of composite materials will be followed by a history of their use and development within the sport. Design manufacture and operation of composite structures are reviewed. Reference is also made to their energy absorbing properties that have contributed so significantly to the improved safety record of Formula 1 and the more specialist composite materials, such as carbon–carbon, used in brakes and clutches.



## 1. The design of Formula 1 racing cars

The general arrangement of single seat racing cars has remained the same since the early 1960s. The central component, which accommodates the driver, fuel cell and front suspension assembly, is the chassis (Fig. 1).

This is a semi-monocoque shell structure which is more like a jet fighter aircraft cockpit, both in terms of shape and construction, than anything one would expect to find on the road. The engine, in addition to providing propulsion, is a structural member joining the front and rear of the chassis. It is attached directly to the rear of this unit by high strength metal studs (Fig. 2).

The assembly is completed by the addition of the gearbox and rear suspension assembly (Fig. 3.).

The gearbox, in addition to carrying the transmission is the rear section of the chassis. The car's primary structure of chassis, engine and gearbox (Fig. 4) may be considered as a "torsion-beam" arrangement carrying the inertial loads to their reaction points at the four corners.

The secondary structures (bodywork, undertray, wing configurations and cooler ducting, etc.) are arranged around and attached to the primary structure at various points (Fig. 5).

A Formula 1 car is driven "on the limit", that is to say one aims to operate the car as close to the point where its longitudinal *g* is just about to be overcome due to the lateral *g* from cornering (Fig. 6).

The car must be "set-up" for each individual circuit in order to optimise performance. Changes are made to the aerodynamic devices and the suspension elements (springs, dampers, anti-roll bars and so on) in an attempt to improve its lap time. Changes in the performance levels of the various sub-components must be manifest in the balance of the car. Clearly this will not occur if the structure transmitting the loads is not of adequate stiffness. In common with many other engineering disciplines, the designers of Formula 1 racing cars are required to comply with a stringent set of regulations. The rules are imposed by the FIA, the Sport's governing body. Constraints are laid down on geometry, strength and weight. Strict limitations

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**Fig. 1.** The chassis is the central component of an F1 car.

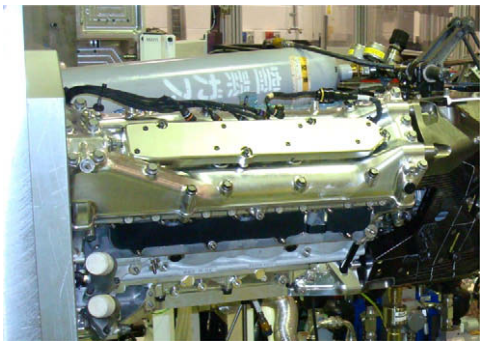

**Fig. 2.** Engine.

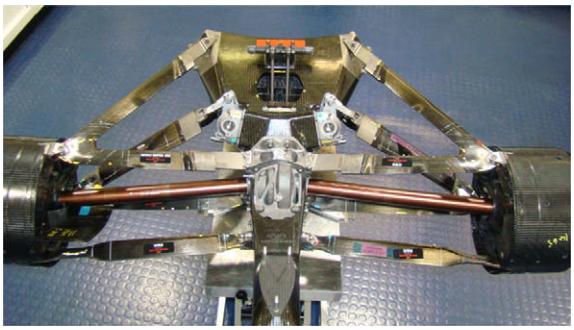

**Fig. 3.** Gearbox and rear suspension.

are placed on the overall dimensions of the cars and the sizing of the driver envelope within the cockpit. A series of statutory regulations have been introduced over the years which are continually updated to improve safety. Consequently, the chassis has developed a secondary function of a "survival cell" to protect the pilot in the event of a crash. A number of tests must be performed in the presence of an official prior to the car being certified for Grand Prix usage. The regulation limiting the minimum weight of the car plus driver to 605 kg is of great significance. Building a car to the weight limit is a vital task if it is to be competitive.