FEATURE

Teijin's advanced carbon fiber technology used to build a car for the World Solar Challenge

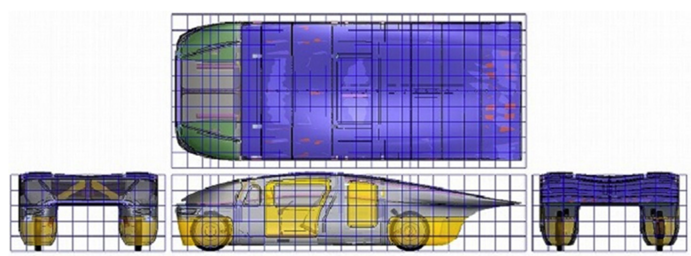
Shunsuke Tamura

The biennial World Solar Challenge is the world's biggest solar car race which covers 3000 km across Australia from Darwin to Adelaide. OWL, an advanced solar-powered car developed by Kogakuin University using Teijin's carbon fiber reinforced plastic (CFRP) for its chassis and body structure, participated in the race from Japan and finished in second place.

The concept of OWL

The race is divided into three separate classes and Kogakuin participated in the Cruiser Class. Participants in the Cruiser Class race with one driver, one passenger and a restricted amount of luggage in each vehicle. There is a practical scoring method and OWL focused on reducing transit time as it accounts for 70 percent of the score.

Drag minimization is the most important task for the World Solar Challenge participants. OWL has a large tunnel in the middle of the vehicle under the two-seater body to reduce its frontal projected area as well as ensure comfort while clearing the regulations. The frontal projected area is reduced by using leading arms for the front suspension and trailing arms for the rear and placing them in front of and behind the tires and driver.

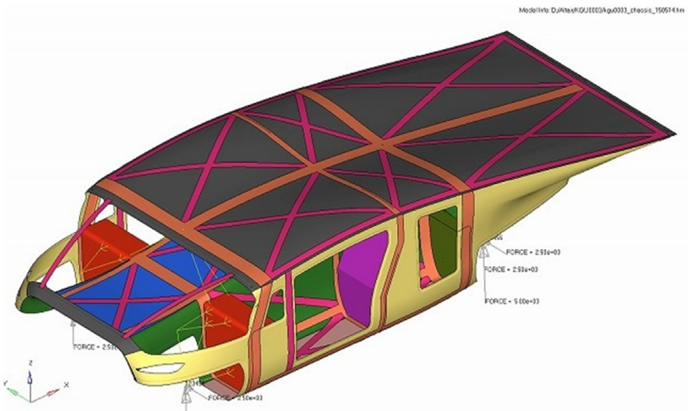


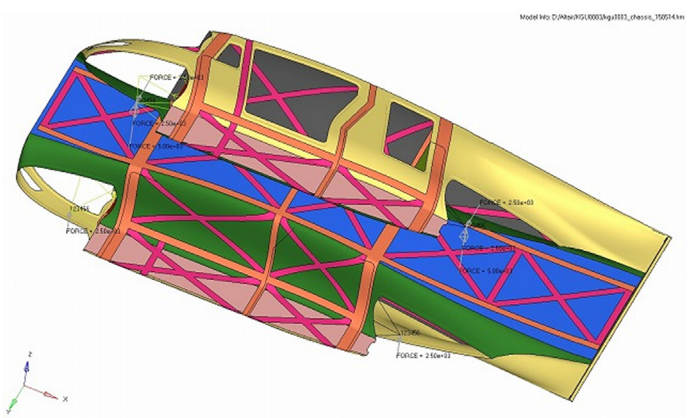
The structure of OWL

An ultra-lightweight fabric as thin as 0.06 mm made with Tenax® W-1105 CFRP pre-impregnated with matrix resin (prepreg) was used to design and fabricate OWL's body and enabled its body-weight to be reduced to 55 kg. Conventional solar cars have solar panel modules on detachable roofs and those vehicles need to ensure the tensile modulus (rigidity) by adding frames in the vehicles. However, OWL has an advanced structure with a minimum number of frames and an advanced fixed roof. The main surface is partly reinforced by separating ranges and laminating uni-direction (UD) in cross-ply layers in order to improve torsional rigidity.

The roofless front end loaded by front tires is one of the most critical features for strengthening the stiffness in OWL's chassis and body structure. To achieve this, the front consists of banding-layered t-30 mm honeycomb which joins the front BHD, A-pillar and the ceiling's leading edge, as well as a high-tensile modulus front roll hoop with UD-layered CFRP on the surface.

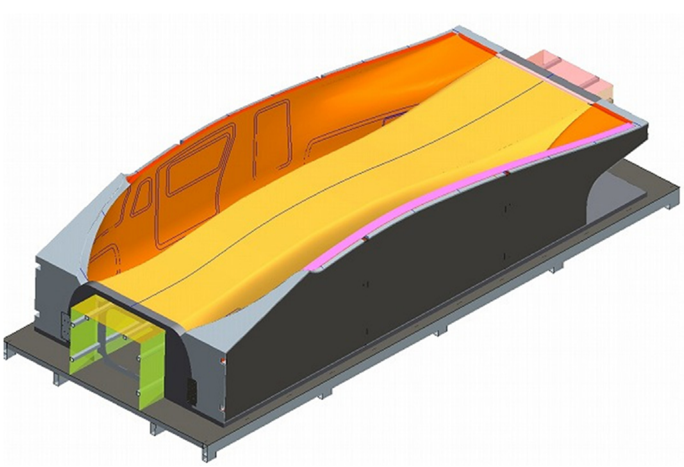
0034-3617/ http://dx.doi.org/10.1016/j.repl.2015.12.078

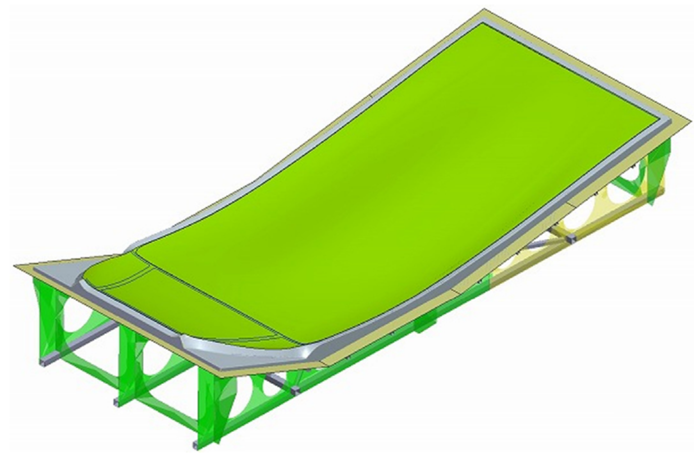




Parting of OWL

The direct female mold was made by milling machine. The lower body has maximum integral structure to minimize assembly operation in post-processing and secondary adhesion in order to form OWL's ultra-lightweight chassis and body. The mold has tunnel section in the middle, which allows for a reduction in the mold's weight and effective heat transmitting conditions during the prepreg curing process.





Molding of OWL

The fabrication of OWL's ultra-lightweight chassis and body parts including spats and doors were layered by release films and integrally formed in a large mold. The technique effectively reduced distance between parts and also contributed to drag reduction. The upper surface's lamination structure is as thin as carbon fiber: $t = 0.12$ mm/honeycomb: $t = 12.5$ mm/carbon fiber: $t = 0.12$ mm, and still keeps enough rigidity as the front panel. The UD and $t = 30$ mm honeycomb core are layered at every important point to ensure the vehicle's entire rigidity.

The molding of the lower body was unique and challenging. The forming dies of the lower and side parts were separately layered up to