# Travail de fin d'études et stage[BR]- Travail de fin d'études : Preliminary Design of a Transverse Composite Leaf Spring for Electric Vehicles[BR]- Stage d'insertion professionnelle

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# Preliminary Design of a Transverse Composite Leaf Spring for Electric Vehicles

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**Abstract:** With growing demand in battery electric vehicles, car manufacturers are facing new challenges in mass reduction and space optimisation of the suspension designs. A possible solution to this problem is to integrate several suspension members into a single, more compact transverse composite leaf spring. The aim of this Master's thesis is to develop a reliable and general analytical method allowing the computation of a preliminary design for transverse composite leaf springs.

The analytical design methodology starts with the definition of the starting independent suspension in which the leaf will be integrated and the choice of laminate material for the manufacturing of the leaf spring. The possible designs of the leaf based on the integrated suspension members are then established. The leaf is modeled using classical beam theory and classical laminate plate theory together. A method to compute the suspension forces graphically is then derived and paired with a two-dimensional kinematic model of the suspension to fully determine the configuration of the suspension along the wheel stroke.

This analytical method is then applied to the 2004 Audi A6, which has short long arm suspensions on its rear axle. This results in two different geometries of the leaf springs: one leaf of 11mm thickness, 100mm width and length of 1340mm, the second one with the same geometry but a thickness of 17.3mm. This last leaf design gives an equivalent roll stiffness of 936Nm/deg on the rear axle, as it integrates the anti-roll bar properties. Kinematic performance curves of the transverse leaf spring suspension are assessed and give similar/close results compared to the original coil spring suspension design. For each leaf design, stresses are computed and the Tsaï-Wu failure criteria is verified. For all designs, the criteria is met.

Finite element analysis is performed on the obtained leaf designs. Using NASTRAN SOL 402, assumptions on the large deformation of the leaf springs are verified. This leads to the conclusion that the model used for the first leaf design has to be improved when the leaf experiences very large deformations. On the other hand, the model for the second leaf design can be simplified by considering that the large deformation of the leaf is given by an equivalent rotating rigid arms. Modal analysis of the leaves using NASTRAN SOL 103 shows that the natural frequencies of the leaves are all greater than the frequency due to the road surface irregularities (12Hz).

**Keywords:** automotive, suspensions, double wishbone, SLA, electric vehicles, laminates, GFRP, CFRP, large deformations