Numerical-empirical-based function for the assessment of the stiffness distribution on automotive body panels

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Abstract. Nowadays trend of developing highly-fashionable vehicles poses the problem of defining verifications procedures to evaluate the influence of the chosen panels shapes on their mechanical performances. The stiffness of the vehicle panels (i.e. fender, roof, doors, etc.), manufactured by means of sheet metal stamping process, is a main concern for the automotive manufacturers and must be assessed already in the early design stages. Accordingly, this research proposes a stiffness function, one for each body panel, which correlates curvature (major and minor) and variation of curvatures with the local stiffness characteristic of the panel, to be utilized for the stiffness assessment based only on the design model, without the need of an industrial testing. By utilizing automotive panels belonging to different five existing vehicles, indentation tests have been carried out on different part locations and the load-stroke results have been utilized for the validation of the developed numerical model, utilized for further analyses. By means of the implemented numerical model, indentation tests have been carried out and the results, in terms of load-stroke curves, have been utilized for the calculation of the stiffness index (SI) value, defined as the ratio between the load-stroke curve integral of the measured indentation point and that of the defined reference curve. Accordingly, a regression function correlating curvatures and variation of curvature with the SI values have been defined including a penalization factor in case buckling occurs, showing R2 values always >90%. The proposed calculation procedure has been implemented in a self-developed GUI (graphic user interface) and allows the quick estimation of possible low-stiffness points of newly designed panels almost in the real time, without the need for any additional numerical simulation. The proposed approach, as implemented in the developed numerical simulator, allows identifying possible weak points of the design already in the early stages of the design phase enhancing the reliability and effectiveness of automotive body panels.

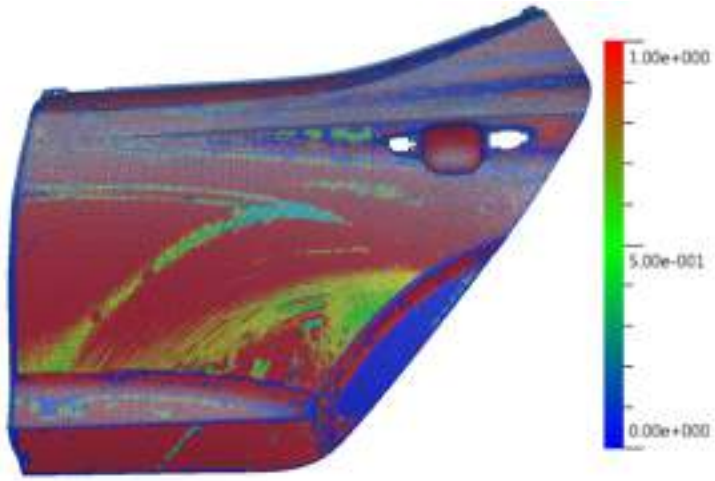

Fig. 1 Stiffness index (SI) simulator result example (SI≈1, high stiffness; SI<1, low stiffness).