D5.1 Report on dynamic material performance

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Deliverable Information sheet

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Executive summary

This deliverable was prepared within the framework of WP5 in the Sup3rForm project. It addresses the dynamic material response for four 3rd-generation advanced high strength steel (3rd Gen AHSS) selected in WP3 for further investigation. The aim is to analyse the effect of increased strain rate on the mechanical behaviour of the steel grades which will be used as a foundation for the rate-dependent material model calibration in WP6 and crucial for the final virtual crash testing of structural components in D6.2 in M30. The work is based on a comprehensive experimental campaign to extract high-speed uniaxial tensile properties, post-yield flow stress behaviour, stress triaxiality evolution to fracture, as well as fracture toughness measured using the Essential Work of Fracture (EWF) methodology at high loading rates. This will complement the quasi-static testing results presented in D2.1 and D4.1.

Overall, the results showed a significant increase on the yield strength and tensile strength of the selected 3rd Gen AHSS with increasing strain rate, where Q&P1200 EG VAS and HF1180-Q&P GI AM showed the largest increase in strength followed by HF980-Q&P GI AM. MMn1000 UC VAS displayed the lowest increase in strength with increasing strain rate. MMn1000 UC VAS showed consistently high fracture strains for all stress states. Regarding fracture toughness, an increase was seen at higher loading rates, but the confidence in the results for the 1200 MPa materials are low due to high experimental scatter and load limitations of the machine.

Two parts in this deliverable are delayed:

First, the lap-shear testing to be performed by LTU is delayed since the specimens used in T3.4 were incompatible with the high-speed VHS-160/100-20 tensile testing machine. A new specimen suitable for the high-speed testing setup has been developed, but due to a concern that the asymmetric layout of the specimen would induce side loads which the machine cannot handle without risk of damage, some extra sanity checks and simulations are necessary. Finally, some of the loads measured in T3.4 were too high for the high-speed machine to handle, so the welding conditions need to be adapted to suit the high-speed machine. These checks are to be finished in January 2026, and if successful, the order will be sent to CRF for producing the specimens. The delay of this task affects Task 6.6, but quasi-static results from Task 3.4 can be used in the meantime. The delivery will have to be updated with these results.

Second, Task 5.4 covering the influence of strain rate on microstructure evolution and fracture mechanisms is also delayed due to the delay of Task 5.2. Apart from the lap-shear tests, the experimental work in this task is now completed, and contact has been initiated to proceed with the analysis of specimens fractured at higher loading rates.