AJPU: An overview of tools and machines to characterize adhesives at impact conditions

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ADVANCED JOINING PROCESSES UNIT

Introduction

The increasingly larger use of adhesive joints in the automotive industry demands accurate adhesive characterization under dynamic loadings. Thus, leading the present group to develop testing machines with the aim of studying bonded joints. Specialized machines were designed since that allows the flexibility of perform both adhesive characterisation tests and assess joints performance. Machines such Drop-weight machine [1] and Split Hopkinson Pressure Bar (SHPB) [2,3] were created, as well as a special apparatus [4] to determine fracture energy, that can be used in both commercial servo-hydraulic testing machines and the drop-weight presented in this poster.

Drop – weight machine

Figure 1 displays the setup of the drop-weight machine. While the pre-loaded piezo-electric sensor press force and the accelerometer follows the classic method of designing drop-weight machine, the high frequency laser distance sensor and the custom fixture were specifically chosen due they flexibility they borrow to test different type of specimens usually used when adhesive joints are study.

Figure 1 – Drop weight machine, primary sensors and custom fixture.

As mentioned before, the flexibility of an in-house developed drop weight machine allowed the group to develop different test setups to respond to different challenges. In the left part of Figure 2, a custom setup for testing a header of a car under impact loadings, for the automotive industry is shown. In the right picture of Figure 2, and apparatus to determine the fracture energy under both mixed mode conditions and impact loadings, developed in – house can be seen.

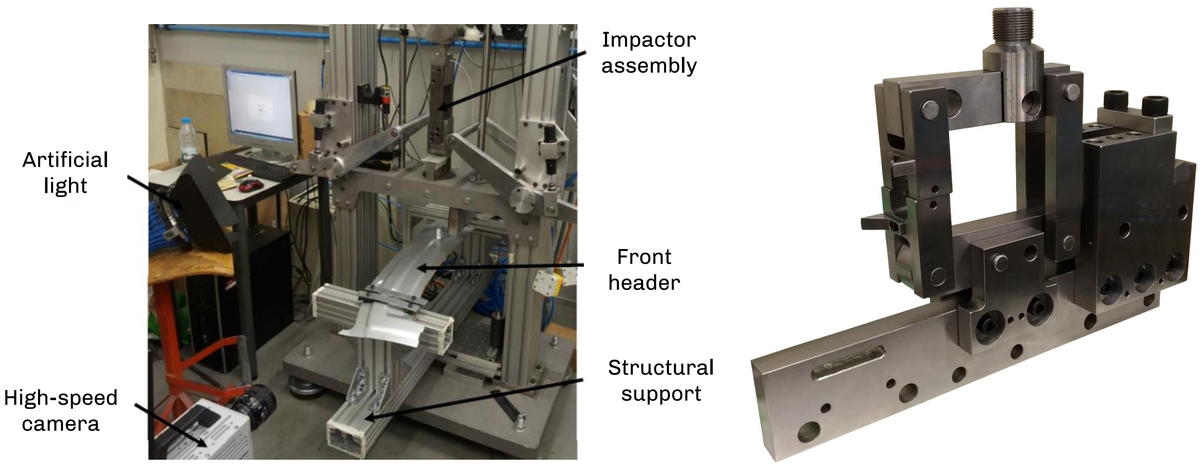

Figure 2 – Testing setup for a real joint (left), image of the mixed mode apparatus (right)

Split Hopkinson Pressure Bar

The working principle of a SHPB, represented in Figure 3, consists in launching a striker at high velocity that impacts into a setup bar-specimen-bar generating a stress wave that will load the specimen. For this machine, a novel pneumatic apparatus was designed, allowing tension and compression tests, as well as precise speed control of the striker bar. A special braking system was also developed in order to ensure the proper operation of the actuator.

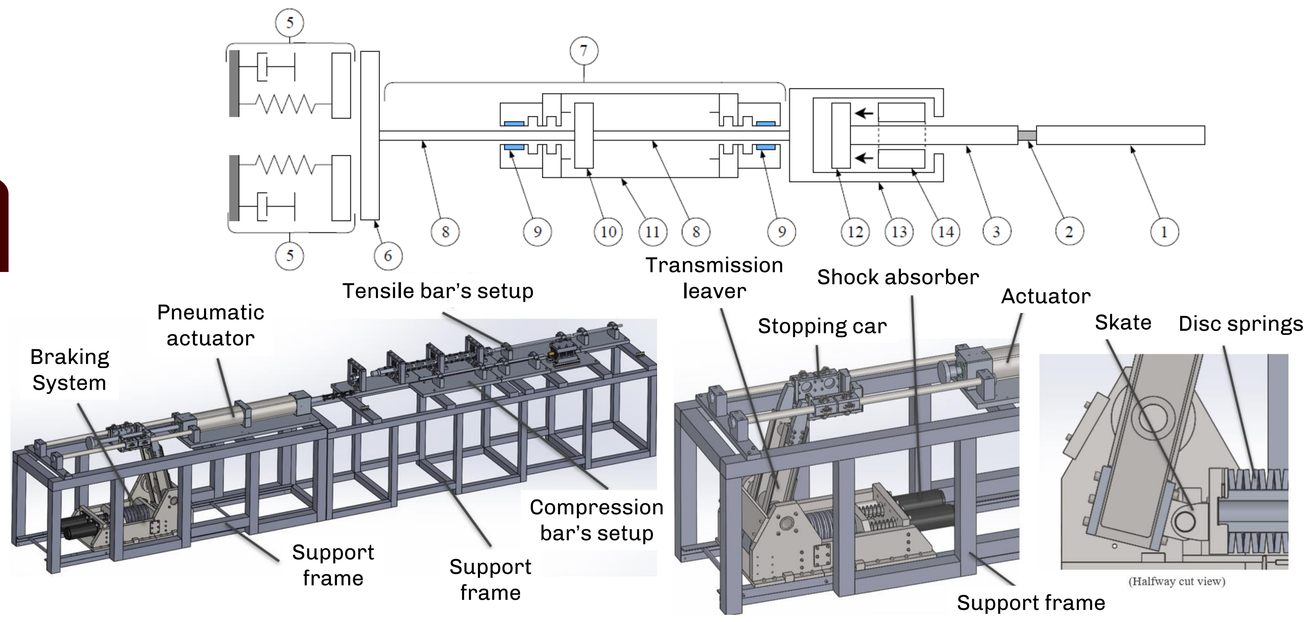

Figure 3 – Scheme of a representation of an SHPB machine.

Figure 4 shows a representation of the substrates used to determine the fracture energy of adhesives under tests speeds up to 25 m/s and different loading directions.

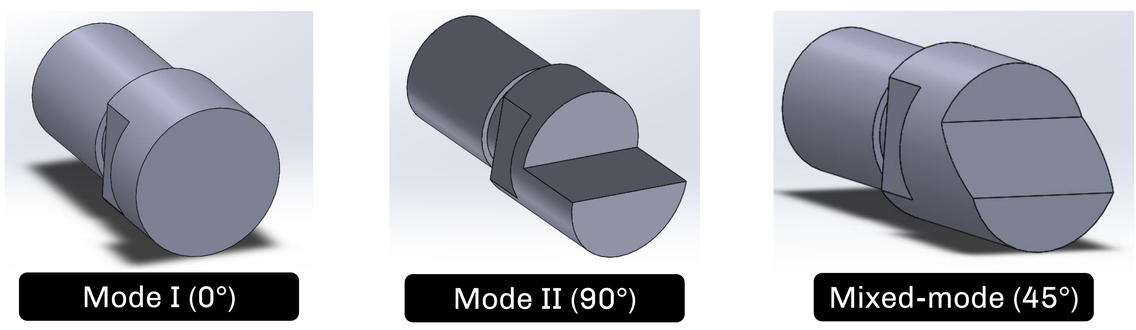

Figure 4 – Representation of the substrates of the novel SHPB specimens for different mode configurations.

Conclusions

- The study of the impact behavior of adhesive joints is fundamental for the design of lightweight, crash resistant structures;
- Several material characterization processes have been successfully used for the determination of strain rate dependent mechanical data, supporting the design optimized impact resistant bonded structures.

References

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