

THERMOELASTIC STRESS MEASUREMENTS ON IMPACTED WOVEN COMPOSITES

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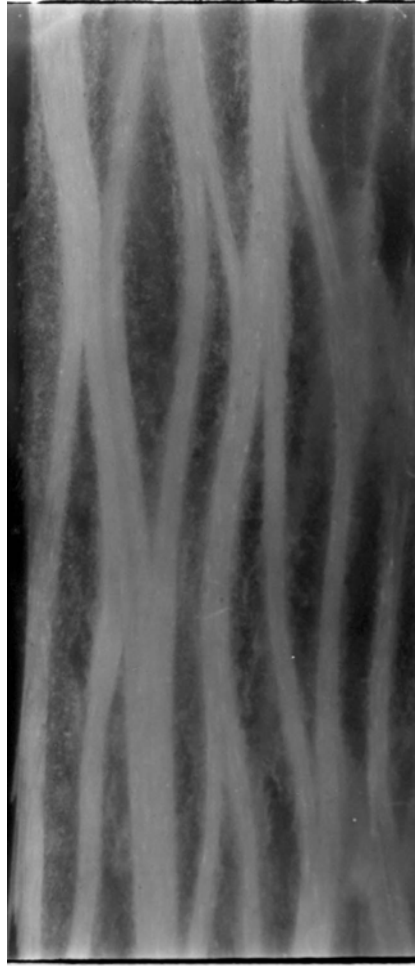
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EXPERIMENTAL AIMS

- Assessment of impact damage by thermoelastic strain measurements during post-impact fatigue tests
- Application to the case of woven composites: influence of the structure on the thermoelastic signal
- Study of the variation of thermoelastic signal with frequency for different impact energies

MATERIALS

- **Polyester-glass** laminate woven with **E-glass fibres mat**
- **Resin:** unsaturated polyester coupled with styrene
- Paper on paper lamination by **RTM**
- **Fibres content:** 63% volume.



Structure of the plain woven laminate (side magnified 10 times)

IMPACT

- **Impact energies:** 5, 7.5, 10, 15 J
- **Impact procedure:** different energies were obtained by varying the mass of the drop-weight impactor, whilst maintaining the impact velocity at 2 m/s ($\pm 5\%$)
- **Impact machine:** CEAST Fractovis



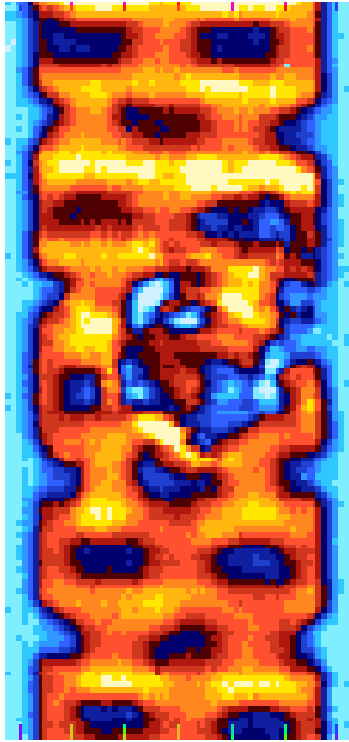
Specimen impacted at 15 J

POST-IMPACT FATIGUE

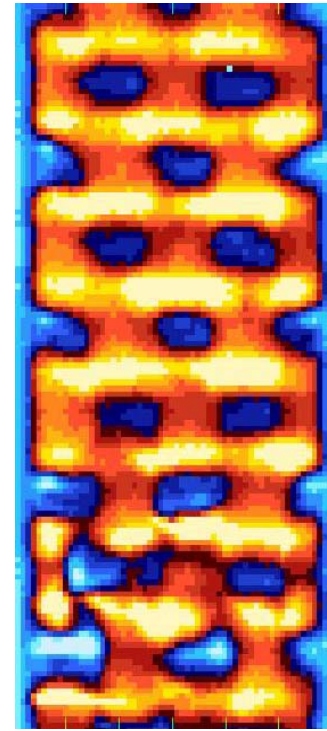
- Max. stress applied: 25 % of ultimate tensile strength
 - Fatigue cycle ratio: 0.5
 - Frequency: from 5 to 30 Hz.
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- Thermoelastic stress analysis by Deltatherm 1000
 - Images were averaged on a 2.5 minutes period.

INITIAL RESULTS

- The thermoelastic signal strongly depends on the structure of the woven composite: different regions can be distinguished
- The presence of irregularities in the structure is also discernible, although the reference of it to impact damage is not always possible



10 J

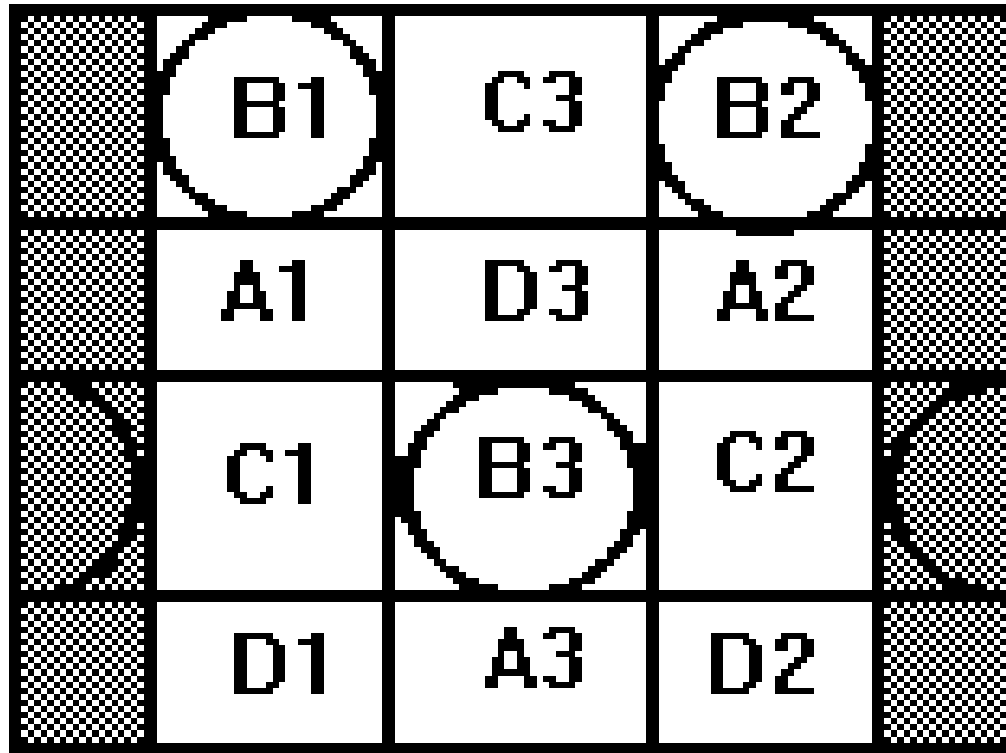


15 J

Specimens shown after 10^5 cycles of post-impact fatigue testing

DATA ANALYSIS

- The structural unit including the impact region was in particular observed
- The regions showing different thermoelastic signal (A,B,C,D) were separately considered
- Every specimen underwent to 10^5 cycles at 10 Hz and was then tested for 2.5 minutes from 5 to 30 Hz.



Regions of the specimen in the impacted zone

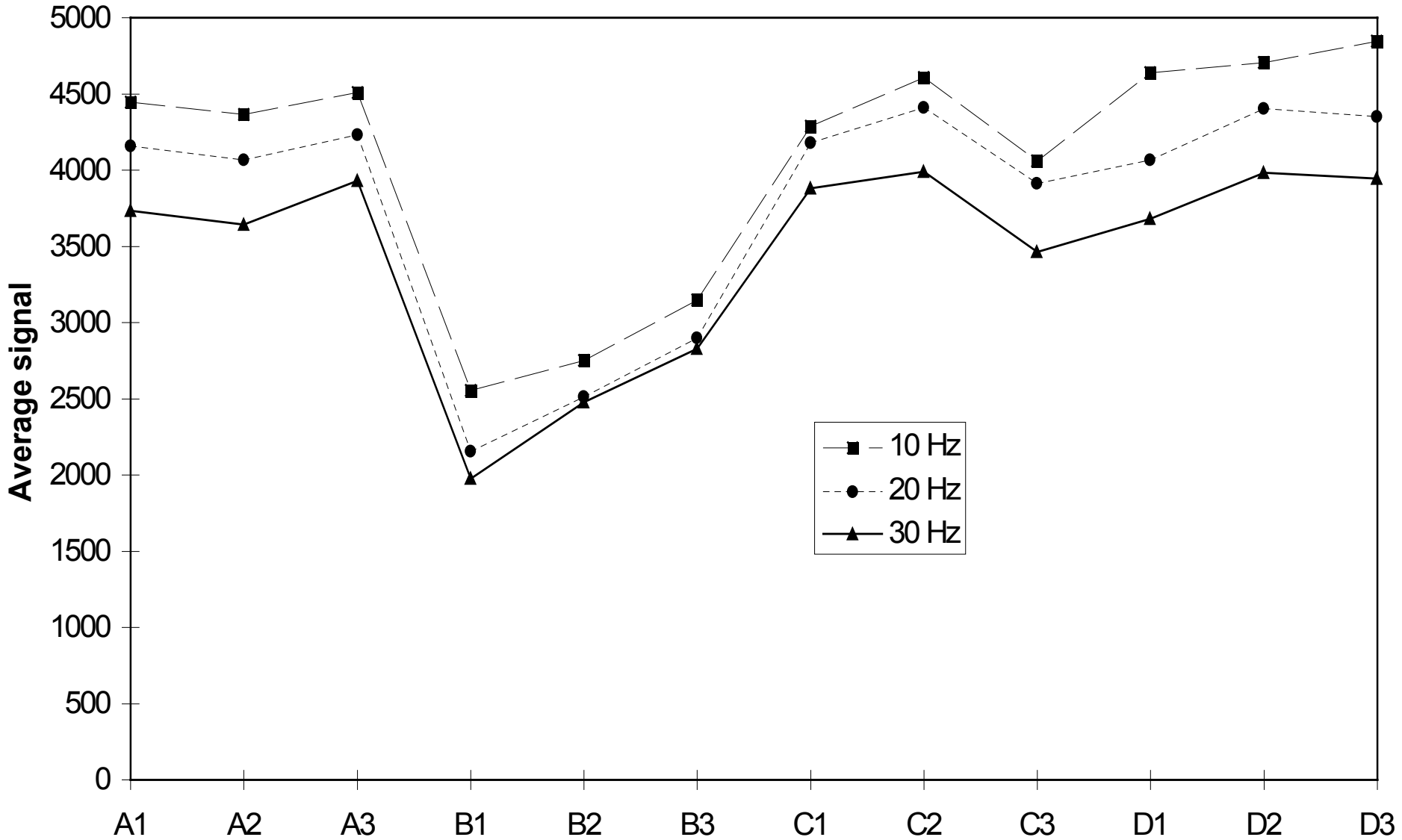
White= Central regions analysed

Grey= Edge regions not analysed

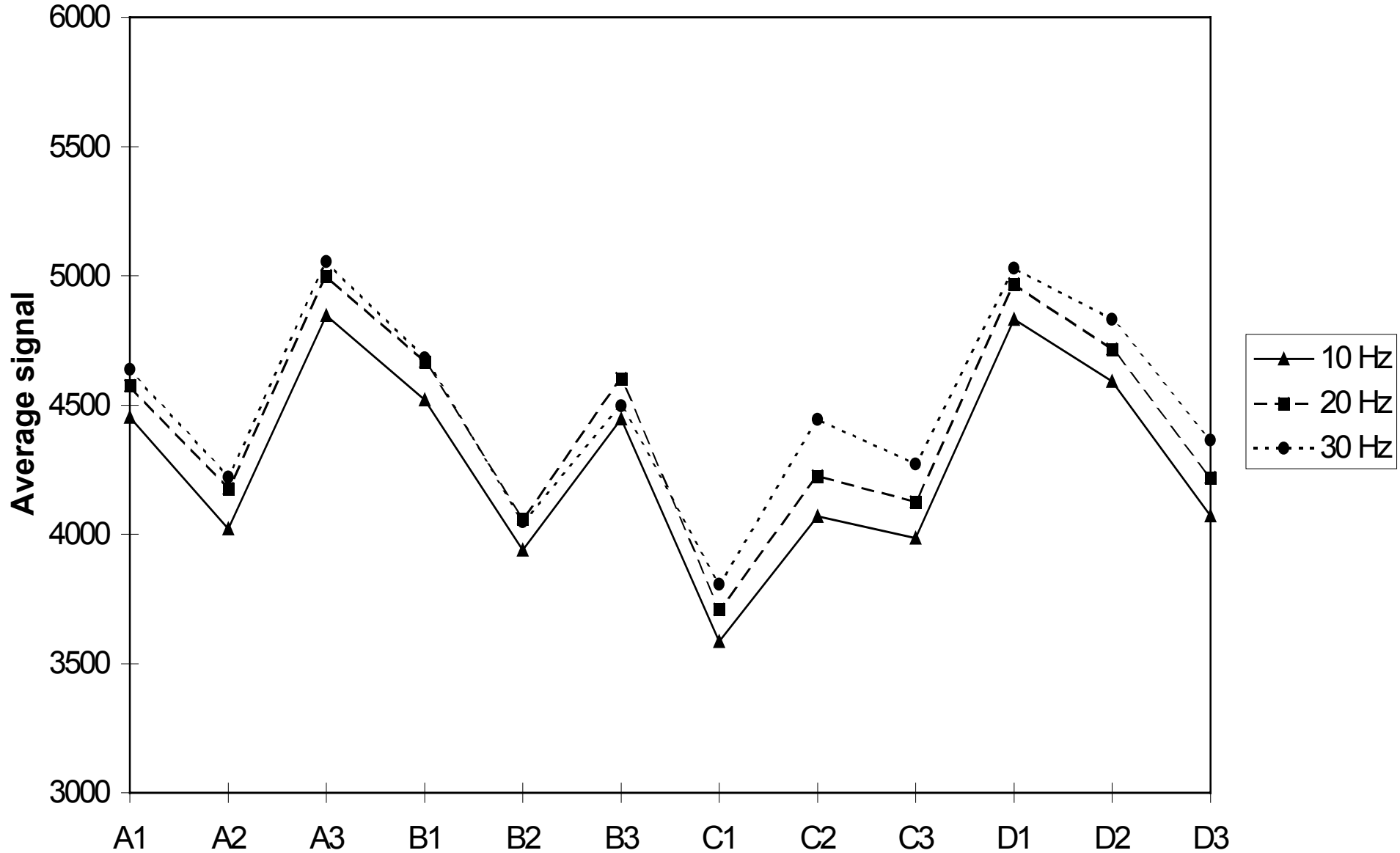
SIGNAL VARIATION WITH FREQUENCY

- In not impacted composites the signal decreases with frequency in every region
- In impacted composites the signal may vary according to different patterns, from a global increase with frequency (5 J) to more complex patterns (10 J)
- About 75% of the points showed a thermoelastic signal in a $\pm 10\%$ range from the average

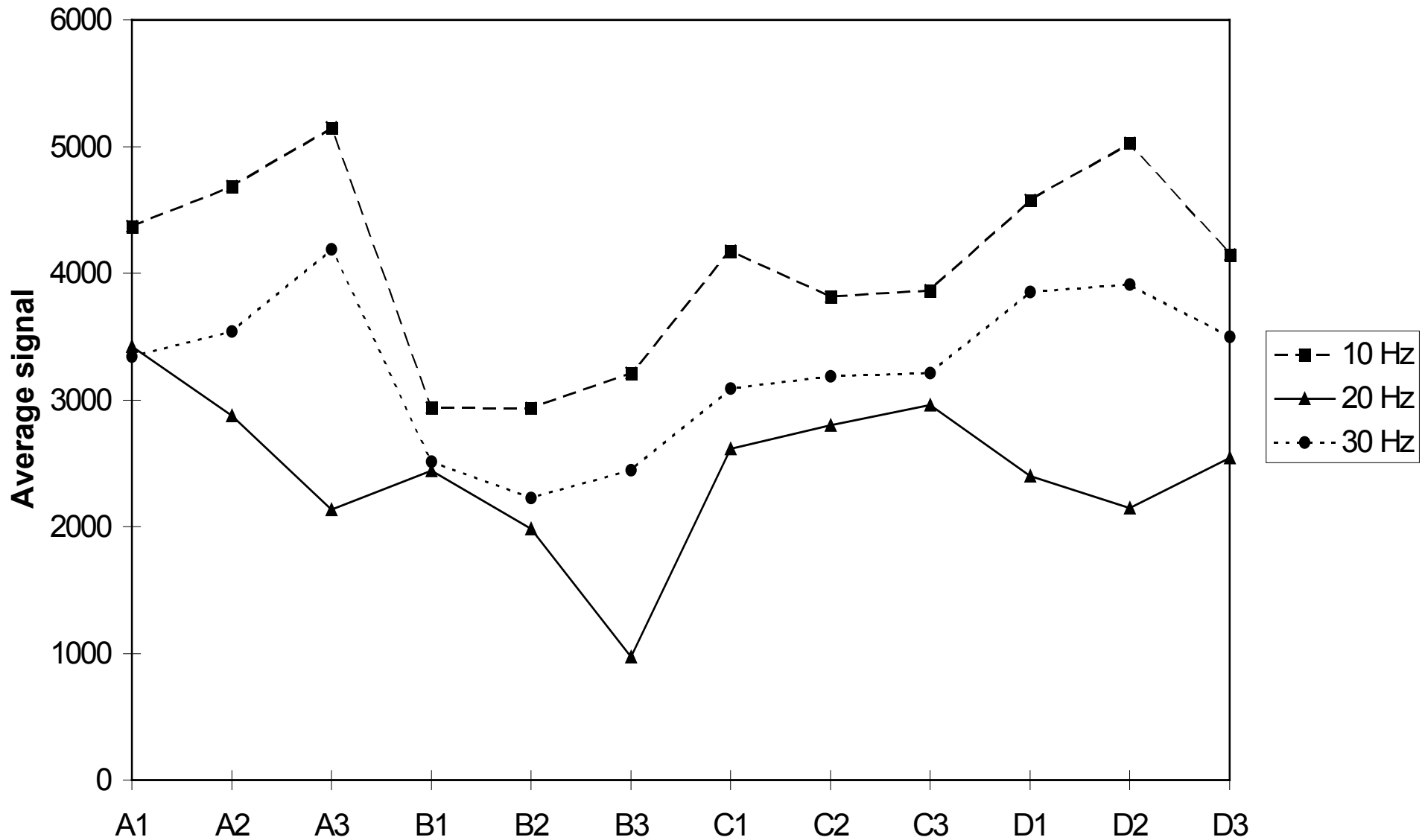
Not impacted



Impacted 5 J



Impacted 10 J



FURTHER ANALYSIS

- To observe signal patterns with increasing stress
- To compare the signal in the region including the impact and in the other regions of the laminate
- To consider the possibility to discern impact damage and post-impact fatigue damage
- To analyse more deeply the influence of frequency on the signal with growing impact energy
- To measure the variance and other statistical parameters of the results obtained