Composites Research Network

Thermal Contact Resistance and Process Modelling

SUMMARY

ArmorWorks Canada is a division of the global company ArmorWorks, which designs and manufactures advanced survivability products including personal protective equipment, hard armour for vehicles and blast attenuating seat systems. The Canadian division specialises in hard composite armour used in vehicle seat systems to protect occupants from the shrapnel from improvised explosive devices. Much of the hard armour is produced from a fibreglass-phenolic resin prepreg material consolidated and cured in an on-site autoclave. As with many other composites companies, ArmorWorks has limited access to technical resources or process modeling. Based on previous experience in process modeling research, CRN staff proposed a project to include thermal contact resistance effects to better model the forced heating and cooling effects in composite manufacturing systems. With the intent of learning about current best practice manufacturing and to improve process modeling skills for future use, ArmorWorks joined CRN's existing project with AS Composites to better understand the fundamentals of thermal management. AS Composite is a Canadian manufacturer of composite sandwich panels.

CHALLENGE

Best-practice process models for predicting thermal histories, residual stresses, and geometry-dependent spring-in angles currently have limitations. One limitation is the absence of thermal contact resistance data in the process history. This project uses thermoplastic processing as a case study to extend previous research by CRN staff to include contact resistance in process modeling activities. The approach can also be extended to other areas, such as autoclave manufacturing used by ArmorWorks. Canada.

ArmorWorks Canada Inc.
Winfield, British Columbia

ArmorWorks Canada manufactures various survivability products including blast attenuating seat systems designed to protect vehicle occupants from improvised explosive devices. The armour components are sold to OEMs that subsequently assemble and market the completed vehicles.

AS Composites Inc.
Point-Claire, Quebec

Client Contacts

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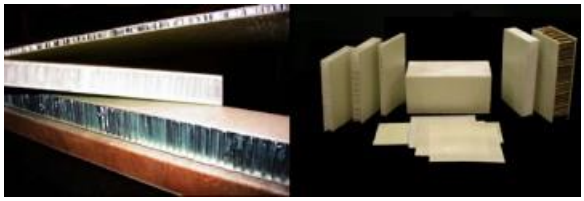
APPROACH



Sandwich panels manufactured by AS Composites.

Initially, a literature review by CRN captured the current state of knowledge of the effects of thermal contact resistance on a composites manufacturing system. Using this foundation, a predominantly experimental approach was adopted by CRN staff to quantify the phenomenon. Researchers used a LaserComp FOX50 thermal conductivity tester, which is sensitive to temperature, pressure, and surface roughness variations, to characterise a series of stacked steel and composite samples. The aim was to simulate tool-part thermal contact resistance.

OUTCOME

The project revealed that the interfacial thermal conductivity and coefficient of heat transfer between a simulated mould and composite material are dependent on processing parameters. In this case study, the sensitivity to pressure has been shown to be more significant than temperature sensitivity, where the former is of the order of 10% between 0-65 PSI and the latter is <1% between 23-130 °C.

FOX50 thermal conductivity tester.

IMPACT

The importance of including thermal contact resistance effects in process modeling has been demonstrated by these laboratory-scale experiments. Further work is planned by CRN to support direct validation or implementation. This work may include scaled-up experiments for thermoplastic roll forming, experiments for autoclave manufacturing, and inclusion in future process simulation models.

CONTACTS

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