CARBON – CARBON HONEYCOMB PANELS FOR AIRCRAFT AND HELICOPTER FIREWALLS

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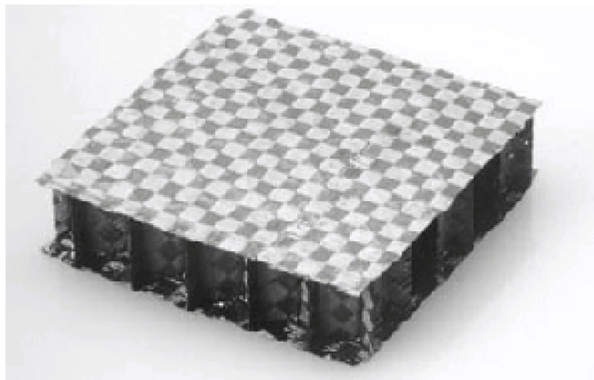

ABSTRACT

Carbon–Carbon composites are enjoying increased use and interest by the Aerospace industry. These materials offer the ability to carry structural loads at very high temperatures and meet all FAA requirements for Fireproof Materials. This paper introduces advances in low-density, Carbon–Carbon honeycomb panels for aircraft and helicopter firewalls.

KEY WORDS: Carbon – Carbon Composites, Honeycomb, Fire Resistance

AIRCRAFT AND HELICOPTER FIREWALLS

The Federal Aviation Administration requires that each engine or other item of combustion equipment, which is intended for operation in flight, be isolated from the rest of the aircraft by means of a firewall or equivalent means. The firewall must be made so that no hazardous fluids or flames can penetrate to the rest of the airframe and be made of a fireproof material. (2)

By FAA Handbook Chapter 12, Fire Proof material is defined as,

"The capability of a material or component to withstand a 2000 ºF (1093 ºC) flame for 15 minutes. For test purposes, there should be not be any flames observed on the back side of the specimen due to flame penetration."

Ultracor Inc. has developed technologies to fabricate low-density, structural Carbon-Carbon honeycomb panels. These materials are proposed to substitute for the conventional stainless steel or Titanium firewalls at a small fraction of the weight of metal firewalls. Depending on the design requirements of the structure, this weight savings could be 75% or greater at competitive costs. The increased stiffness and ability to carry structural loads after fire exposure are additional benefits. Worldwide Patents have been applied for these technologies.

FIREPROOF RATING

Several honeycomb panels were fabricated from a low modulus, Carbon/Phenolic honeycomb and thin, low modulus, pitch based Carbon/Phenolic face sheets. These panels were then processed into high thermal conductivity, high modulus Carbon-Carbon composite structures.

Panel # 1, measuring 305mm x 305mm x 4 mm thick (12 in x 12 in x .160 in), was submitted for testing to the Govmark Organization, Farmingdale NY for compliance to FAA Handbook Chapter 12. The Govmark Organization is an FAA certified test facility for Fire Penetration testing. After 15 minutes at 1093º C and a heat flux of 12.9 W/m² (11.3 BTU/Ft²/sec), no flame penetration was observed. Based on these results, the panel received a "Fireproof Rating."(3).

BACKSIDE TEMERATURE

While conventional metallic firewall materials will isolate the aircraft from flame penetration, there is little effect on backside temperature. For this reason, additional protection of machinery, wiring and plumbing are required. This protection is usually accomplished with the use of insulation blankets or other insulating materials at a cost and weight penalty. Carbon-Carbon composite firewalls offer the potential to reduce or eliminate the need for additional protection.

Experimental

Several Carbon-Carbon honeycomb panels were evaluated in terms of backside temperature. These panels were fixtured vertically and submitted to a Propane torch flame. The nozzle of the torch was directed at the center of the panel and adjusted to yield a front side surface temperature of 1093º C (2000º F) over an area of approximately 50mm (2 in) in diameter. Backside temperature was measured directly opposite the flame. Temperature was also measured 150mm (6 in) away from the center of the panel. The panels were weighed before and after exposure to the flame. Table 3 and Figure 2 show the results.

Results

	THICKNESS (mm)	WEIGHT BEFORE (g)	WEIGHT AFTER (g)	BACKSIDE TEMPERATURE AT 15 MIN (° C)
PANEL # 2	7	137.0	136.8	404
PANEL # 3	13	189.9	189.6	364
PANEL # 4 INSULATED	13	205.2	205.0	337

Table 3: Maximum temperature and weight loss after 15 minute flame exposure

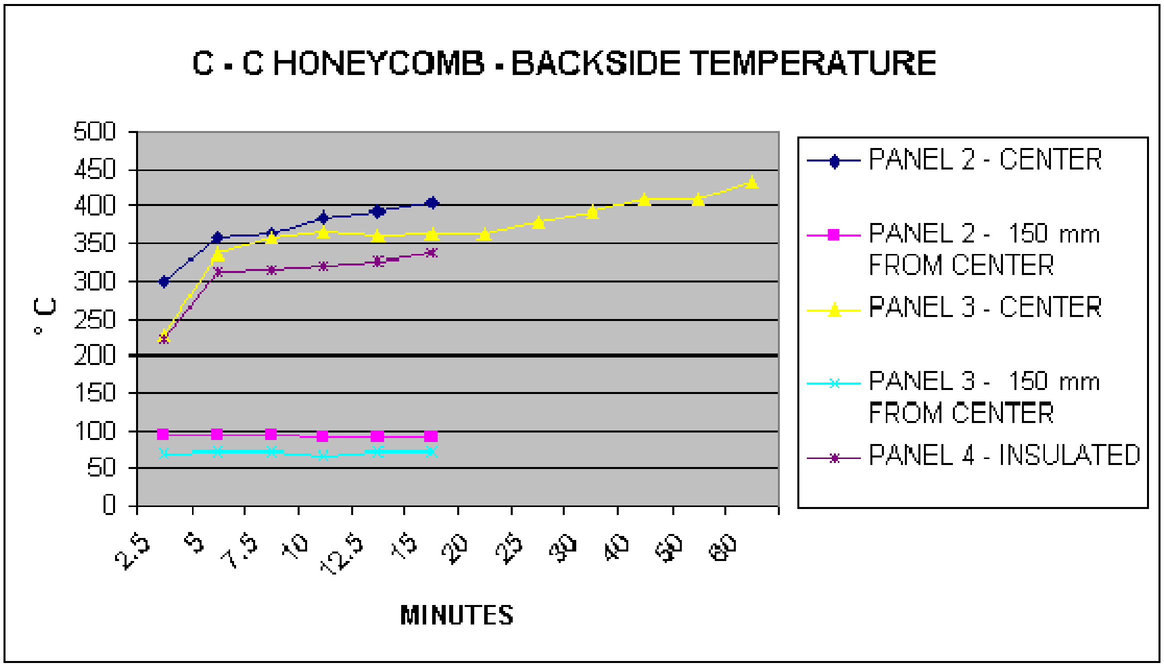

Figure 2: Results backside temperature testing

Discussion

After a 15-minute exposure to the flame at 1093 ºC, there was no penetration or visible damage to any of the panels. The front side of the panels glowed a cherry red. During the first five minutes, the center backside temperature of all panels increased to 313 - 357 ºC. In the following 10 minutes of exposure, the center temperature rose to 337 - 404 ºC at a much lower rate. Increased thickness of the laminate resulted in a lower final backside temperature. High temperature insulation in the cells of Panel #4 resulted in lowering the center backside temperature an additional 27 ºC when compared to the similar Panel #3.

When the backside temperature was measured 150 mm from the center of the panel, the temperature ranged from 70 - 90 ºC depending on thickness. Temperature remained stable during the 15-minute exposure, indicating heat spreading by the highly conductive panels.

Panel # 3 was exposed to an additional 45 minutes of exposure at 1093º C. While the backside temperature eventually increased to 432 ºC, there was no flame penetration or visible damage to the panel.

Given the characteristic of Carbon-Carbon composites to oxidize at high temperature, it was unexpected that there was very little weight loss after exposure to the flame. All three panels lost only 0.2 - 0.3 g during the exposure to the flame.

Conclusion

Carbon-Carbon honeycomb and honeycomb panels have been developed with a wide range of structural and thermal properties. These properties can be optimized for specific applications. For aircraft and helicopter firewalls, these materials have received "fireproof" ratings and offer increased protection, lower backside temperatures and substantial weight savings at competitive costs.

REFERENCES

1. FAA Subpart E - Special Airworthyness, Sec. 125.143 Firewalls and Sec. 125.145 Firewall Construction

2. Test Report 2-30423-0, Govmark Organization, Inc. 8/17/2000