



IMAGE

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THIRUVANANTHAPURAM CHAPTER

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For members only

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From Chairman's Desk

Dear members

First of all let me wish a happy New Year 2012 to all members of ISNT Thiruvananthapuram Chapter and their families. I thank all the members of our chapter for the efforts they have taken for making the One-day National Seminar on NDE of Composite Structures a grand success, which we have organized on 22nd October 2011 at SP Grand Days Thiruvananthapuram. The seminar was well received and the delegates stated that it was very useful and informative.

Again this year, we have a long list of activities and programmes for our Chapter like Level II ISNT certification in Ultrasonic testing, One day Workshop on A to Z of Ultrasonic Testing etc., other than monthly technical talks and expecting continued support of our members.

Also let me thank the Young Scientists Forum of our chapter who also organizes technical talks by our next generation experts. This forum provides a floor to discuss and present the new advancement and research work in the field of non destructive testing. I request all our young members to utilize this opportunity to present their R&D works, new analysis methods and interpretation techniques in this forum with NDT experts having more than 20 years experience in their respective fields.

Again extending all success to our members and requesting your support to the future programmes of ISNT

With thanks

Dr. S. Annamala Pillai

One Day National Seminar on NDE of Composite Structures - A report

Thiruvananthapuram Chapter organized 'One Day National Seminar on NDE of Composite Structures' on 22nd October 2011 at SP Grand Days, Thiruvananthapuram.

The seminar was inaugurated by Dr. A. Jayakrishnan, Vice Chancellor, University of Kerala. In his address he pointed out that one of the best designed composites is the human bone and the realm of composite and its application is expanding. He hoped that the seminar would provide information and data on recent advances in the composites and its non-destructive testing. The function was presided over by Sri. R. Sivaramakrishnan, GM, RPP, VSSC and Chairman, Organizing Committee of the seminar. Dr. S. Annamala Pillai, Chairman, ISNT Thiruvananthapuram chapter welcomed the delegates and Sri. K. R. Mohan Ananthanarayanan, Convener proposed the vote of thanks.



Dr. A. Jayakrishnan, VC, University of Kerala delivering the inaugural address (left to right) Dr. S. Annamala Pillai, Sri. R. Sivaramakrishnan, Sri. K. R. M. Anathanarayanan

Sri. M. Enamuthu, former Deputy Director of Composites Entity, VSSC gave the key note address. It was a virtual walkthrough from the fundamentals of composites to their characterization, fabrication, production and testing. It was very befitting to have such lucid lecture for the seminar.



Sri. R. Sivaramakrishnan Chairman, Organizing Committee, talks about the seminar



Sri. M. Enamuthu, Former Deputy Director, VSSC delivering the keynote lecture



Dr. K. Srinivas delivering the talk on Thermography



Dr. S. Annamala Pillai talks on optical NDT methods



A view from audience

This was followed by invited lectures by industry and institutional experts. Following are the invited lectures

1. Advanced Radiographic Techniques by Dr. T. Shyam Sunder, Principal Engineer, NDE&I, GE Global Research
2. Advanced Ultrasonic Technique by Dr. T. Jayakumar, Group Director, IGCAR
3. Optical Methods, Dr. S. Annamala Pillai, Group Director, VSSC
4. Thermography Techniques by Dr. K. Srinivas, Scientist, ASL, DRDO
5. Characterization of Materials using Ultrasonic by Sri. S. Adalarasu, DGM, VSSC
6. Acoustic Emission Technique, Dr. S. Annamala Pilla and Sri. K. K. Purushothaman, Engineer, VSSC



Chairman Organizing Committee, presenting memento to Sri. K. K. Purushothaman, VSSC, talked on AE Technique



Wing Commander S. Suresh Kumar during the feedback session



Issuing certificate of participation to the delegates

The seminar was attended by around 100 delegates. The seminar was supported by PCI Limited, Gurgaon, Pyrodynamics, Bangalore and AEUT Instruments Trading and Services Pvt Ltd.,

Mumbai. The seminar was well received and feedbacks on the lectures were that the seminar was very useful.

National Seminar NDE 2011

National Seminar on Non destructive evaluation NDE 2011 was held at Chennai from 7th to 10th December 2011. Eleven members of this chapter attended the seminar. Eight technical papers were presented during the seminar. The Best Paper Award was received for the paper titled 'Debond characterization of isogrid-PUIR foam interface using wood pecker instrument' presented by our chapter member Sri. V. P. Unnikrishnan, VSSC.



Members of Thiruvananthapuram chapter during the National Seminar NDE 2011 at Chennai



Snapshots from the National Seminar 2011 (left to right) Sri. S. V. Rajagopal, HPDD, VSSC, Sri. Binu P. Thomas, Holography lab, VSSC and Sri. Binu B, AE Lab, VSSC

ACOUSTIC EMISSION STUDIES ON CFRP HAT STIFFENED FLAT PANELS

B. Binu, K. K. Purushothaman and Jeby Philip

Structural Design and Engineering Group, Structural Engineering Entity,
Vikram Sarabhai Space Center, Thiruvananthapuram

INTRODUCTION

Composite materials are increasingly finding use in aerospace applications due to its advantages over metallic materials like low weight, high specific strength and stiffness. Shroud is a cylindrical structure, which serves as a protective cover for certain systems in launch vehicle. It has to transfer different flight loads. Hat sections are introduced on outer surface of the cylinder to improve the buckling capability of the structure. Two aluminium alloy end rings are bonded at the fore end and aft end of the shroud with adhesives and fastened as interfacing elements with other structural components. To improve the load carrying capacity Aluminium brackets are also provided at the ends. These shrouds will undergo the structural acceptance/ qualification level load tests before the actual use in the flight. Any damage like debonds, delaminations, fiber breakage etc. initiated during the test may lead to sudden failure. Hence the detection of such defects is critical during the structural load tests. Acoustic emission Testing (AET), being very amenable for detecting such defects in real time is finding extensive use as an online NDT of composite structures during the load tests.

In order to study the behavior of the structure compressive destruction load tests were carried out on subscale flat panels with aluminium alloy end fittings. To evaluate the load carrying capability of the support brackets, panels with and without support brackets were tested. Acoustic Emission (AE) monitoring was carried out during the compression load test of the flat panels to detect any degradation like debond/ delamination/ fiber breakage in the composite panel as well as the bonded interfaces.

TEST SPECIMEN

The test specimen is Hat stiffened flat panel made of CFRP having a width of 260mm and height of 500mm as shown in fig.1. These panels are the representative part of the shroud which is 4 m in diameter. The Panels have three hat stiffeners. The upper and lower end of the panel is bonded with adhesives and fastened by composilok fasteners to the aluminium alloy end rings. The lower ends of the panels are provided with support brackets for increasing the stiffness. One panel was tested without support bracket and one

panel with aft end support bracket. The panels were fabricated by Composite Launch Vehicle Structures Division, Composite Materials and Structures Entity, VSSC and tested at testing facility at CMSE. AE monitoring was carried out by AE laboratory, EXMD, SDEG, STR Entity.

AE INSTRUMENTATION

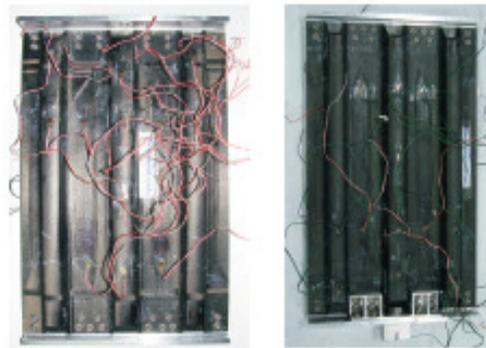


Fig 1 Panels without and with aft end Support Bracket

Acoustic Emission is a phenomenon whereby transient elastic waves are generated by the rapid release of energy from a localized source or sources within a material in connection with defect growth. Typically, the transient elastic waves are detected by an AE system that consists of transducers usually of piezoelectric type, amplifiers, filters and data acquisition system. During the compression tests, 20 numbers of 150 kHz resonant AE sensors were used. Highly viscous ultrasonic couplant (Dow corning vacuum grease) was used to acoustically couple the sensor to the specimen. A schematic of the AE instrumentation of the panel is shown in Fig-2. The circles denote sensors on the backside, dark circles denote sensors in the front and circles with cross mark indicate fastener locations.

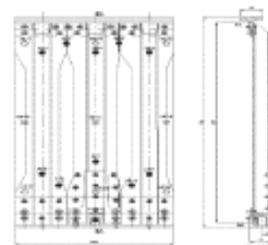


Fig 2. AE instrumentation layout

TEST PROCEDURE

A compression test was carried out on hat stiffened flat panel using an INSTRON UTM. The panel was placed between the lower and upper compression platen of the UTM. The lower end Aluminium end fitting was connected to a fixture. The load was applied gradually with a stroke rate of 1mm/min.

RESULTS AND DISCUSSIONS

Panel without Support Bracket

The specimen was first loaded to 45kN and unloaded. During this 45kN load test, low magnitude AE signals having amplitude levels <70dB, duration <500 μ sec and energy <50 were observed from the lower side of the panel indicating localized matrix cracking in that zone. A significant variation in the magnitude of AE parameters were observed during 20-30kN loading phase (Fig. 3a).

values crossed 15000. These signals are due to the occurrence of delaminations on the panel. The 45kN hold phase did not indicate presence of any active debonds.

The panel was subjected to compression load till destruction/ failure. This time sensors fixed on the lower side of the panel captured signals from lower load onwards indicating further degradation already initiated on the panel in first load test. A drastic increase in the number of signals and increase in AE parametric values were observed during loading phase. A number of higher magnitude emissions were observed when the load crossed 40kN (Fig. 3b). These AE spikes having amplitude levels upto 99dB, duration levels >10000 μ sec and energy values >20000 corresponds to the initiation of delaminations on the lower end of the panel.

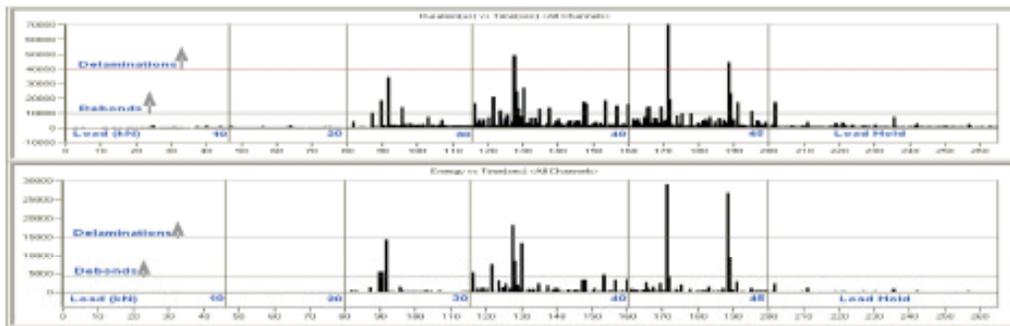


Fig.3a. Duration and Energy Vs Time - 45kN Test- Panel without Support Bracket

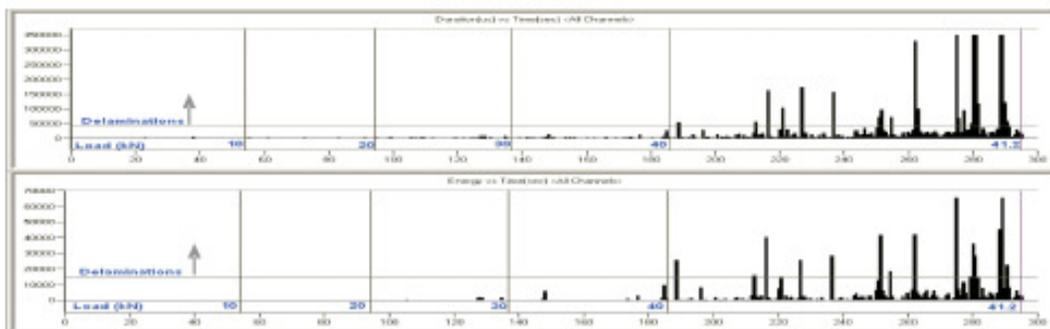


Fig.3b. Duration and Energy Vs Time For Second Load Cycle - For Panel without Support Bracket

A number of higher magnitude intermittent AE spikes were observed from the lower side of the panel having amplitude levels upto 99dB, duration levels >10000 μ sec, and energy values >4000. These signals are corresponding to the initiation of localized interface debonds between the panel and end fittings. On further loading beyond 30kN, increase in number of spikes and the magnitude of AE parameters have been observed. The signal amplitude reached upto 99dB, duration levels crossed 40000 μ sec, and energy

High magnitude AE signals and saturated energy/ duration signals accompanied with audible sounds were observed from the lower side of the panel and the loading was stopped at 41.2kN load. Post test inspection of the panel showed the presence of debonds in the interface joint and delamination on CFRP skin and at the end of hat sections. AE data of this test clearly showed the sequence of degradations occurring on this panel.

PANEL WITH AFT END SUPPORT BRACKET

The specimen was first loaded upto 42kN and unloaded. During this test, AE activity was observed from lower load onwards (Fig.4a). Around 8kN load onwards higher amplitude (>90dB) AE signals were observed. Upto 15kN load, the emissions are mostly from the lower side of the panel having duration <10000µsec and energy <1500, indicating the localized matrix cracking. Significant changes in the magnitude of AE parameters have been observed beyond 15kN load. Intermittent higher magnitude AE spikes having amplitude 99dB, duration >10000µsec & energy >4000 were observed from the lower side of the panel, indicating the initiation of localized interface debonds between the panel and aluminium end fittings. During hold at 42kN, the AE slowly decreased and came to a lower level indicating the absence of active debonds.

corresponding to delaminations were noticed. These AE signals have originated from the lower side of the panel. Beyond 60kN load higher magnitude AE signals of amplitude 99, duration >30000µsec and energy >60000 were noticed which showed the occurrence of delaminations and the initiation of fibre breakages at the interface joint. The AE activity increased further and panel failed at 61.2kN load. Post test inspection of the panel showed the failure at the interface joint at the lower side. The fiber breakages were observed near the fasteners.

CONCLUSION

The capability of Acoustic emission technique for the detection of various defects like matrix cracking, debonds, delaminations and fibre breakages occurring on CFRP structures has been illustrated. The AE signature corresponding to each of the above said

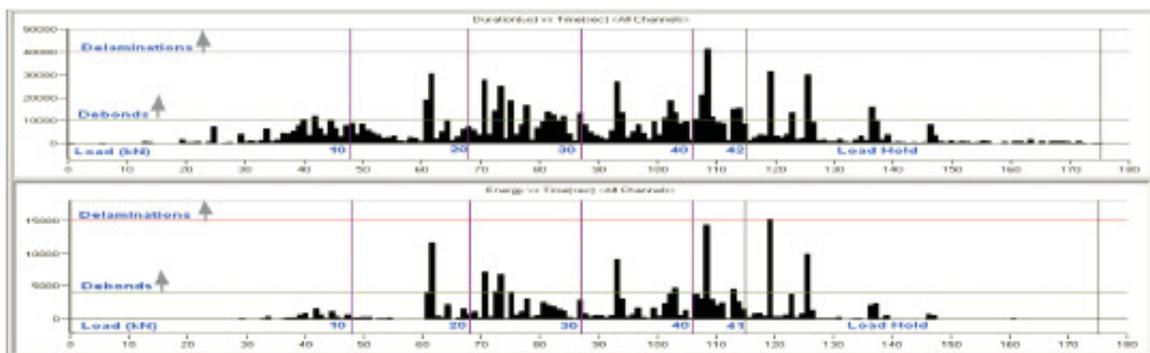


Fig.4a. Duration Vs Time - Destructive Load Test - Panel with Support Bracket

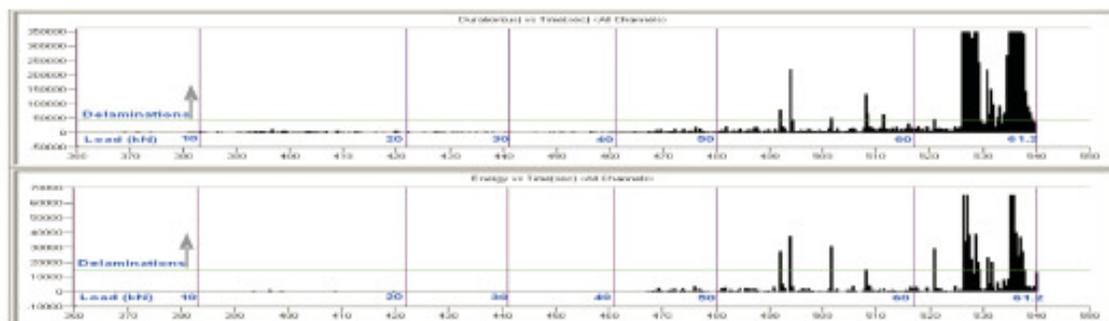


Fig.4b. Duration and Energy Vs Time - Second Load Test - Panel With support Bracket

The panel was loaded again. During this test, AE activity started from the lower side of the panel beyond 42kN load (Fig.4b). Variation in AE parameters were observed beyond 45kN load. Large number of higher magnitude AE spikes corresponding to the occurrence of interface debonds were observed from the lower end of the panel. From 55 kN load, signals of higher magnitude, duration and energy

defects can be utilized for evolving acceptance criteria during the online AE testing of structures made with the similar panels. The online AE analysis can identify the failure initiation and help prevent destruction of the structure so that appropriate corrective action could be taken. The health of the structures made with these panels can be assessed using the acceptance criteria evolved.

ACKNOWLEDGEMENT

Authors wish to thank Sri S. Sridhar, Sri. Sanjay Kumar Singh and Sri. E. S. Vasudev of Composite Entity, VSSC and Sri. Shripati Ingale and Sri P. S. Praveen of Structural Engineering Entity, VSSC for all the support and encouragement for the work reported.

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Best Paper Award

The best paper award was received for the paper titled 'Debond detection and characterization of isogrid-PUIR foam interface using woodpecker instrument' presented during the National Seminar NDE 2011 authored by Sri. V.P. Unnikrishnan, Sri. Atul kumar and Sri. S. Venkata Rajagopal

Congratulations!!



Sri. V. P. Unnikrishnan receiving the best paper award from Dr. Baldev Raj, Former Director, IGCAR

ISNT Thiruvananthapuram Chapter welcomes new members

Dr. D. P. Sudhakar

Sri. K. Senthil

Sri. Shripati Ingale

Sri. Syam G.

Sri. Arunkumar V.

Sri. Sambamurthy Engula

Sri. Suvendu Jana

Sri. Manoj Singh Kathayat

Sri. V. Jayaram

Sri. Karthigai Selvan

Sri. John Paul M A

Chapter activities

1. Executive committee meeting

Two executive committee meetings were held during October 2011 and November 2011

2. Technical talk

Sri. G. Prasanna, Scientist/ Engineer of Composites Entity VSSC delivered a talk on “Acoustic source location through evolutionary geodesics” organized by Young Scientists Forum of ISNT Thiruvananthapuram Chapter on 25th November 2011

3. Member directory

Data for the Member Directory are being collected from the chapter members. Last date for updating the member details was extended to December 2011 and communicated to all our members.

4. Industrial visit

A visit to KMML Titanium sponge Plant is planned during the first quarter of 2012

5. ISNT Certification Level II in Ultrasonic testing

Level II course is planned during the first quarter of 2012. Support from all the members is solicited

ISNT Thiruvananthapuram Chapter website

www.isntvm.org

Kindly visit our chapter website for latest updates.

Welcome your suggestions for further improvement



Editor: Dr. M. R. Suresh.

Editorial board members: S. Ratheesh and S. Vaishnavi

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