Indian Society for
ISNT
Non-Destructive Testing

Image

The Technical Bulletin of Indian Society for Non - Destructive Testing
Thiruvananthapuram Chapter

August -December 2021 Edition

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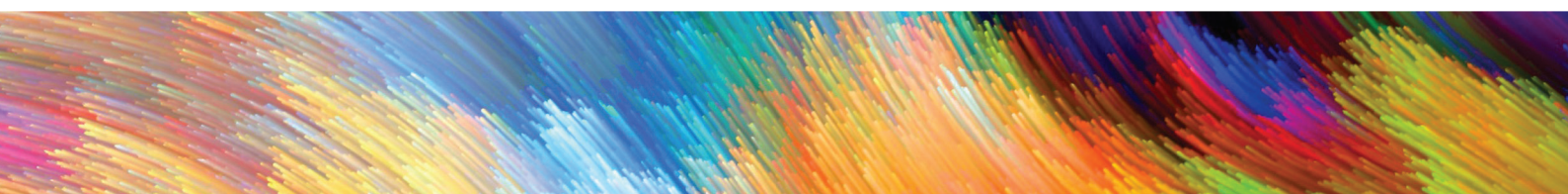

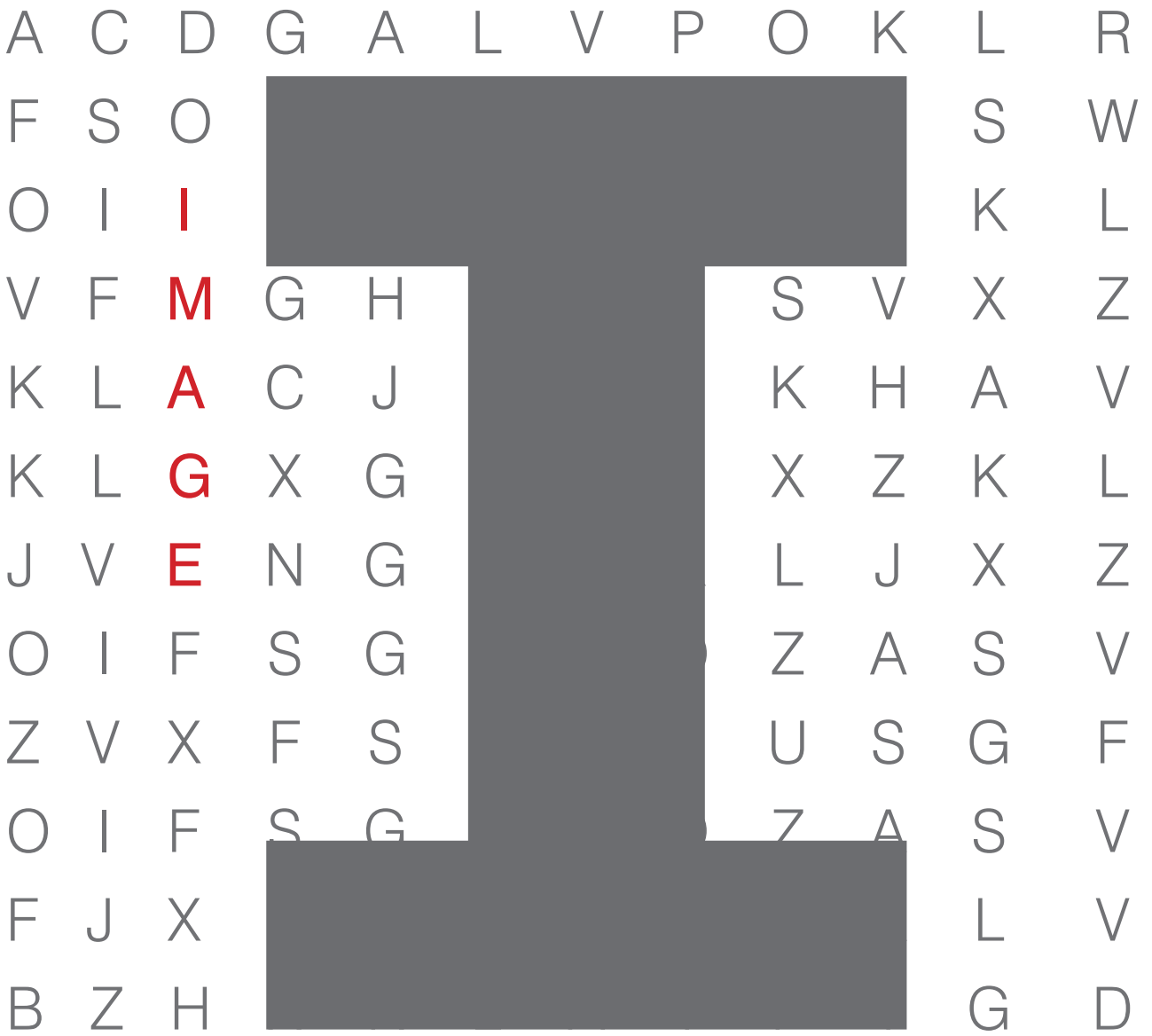
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From the Chairman's desk

Dr. Mohan Kumar L

Dear colleagues,

Warm greetings to all the esteemed members! I deem it as a great honour and privilege to interact with you through IMAGE, the technical bulletin of ISNT, Thiruvananthapuram Chapter. This is the first edition of IMAGE crafted by the new team. The new executive committee took charge in the Annual General Body meeting conducted on 14th August 2021 through online mode. The previous executive committees have set high standards of performance and have made the Thiruvananthapuram chapter one of the best chapters in the country. We shall strive to continue the good work over the solid foundation laid by our predecessors.

The present executive team is an excellent blend of experienced veterans and dynamic young, enthusiastic colleagues. With the threat of the Covid-19 pandemic slowly subsiding, we shall strive to get back to our regular technical activities. The flagship event of ISNT, NDE-2021 was organised in a hybrid mode and as usual, our chapter made its presence visible in a grand way. In addition to a significant delegate presence, many of our chapter members presented high quality research papers in the conference. These papers were appreciated for their technical content and the presentation style. It was a matter of great pride and honour as our immediate past Chairman, Dr. Arumugam M was one of the keynote speakers and chaired a couple of technical sessions in this prestigious event.

Our activities have started off with the talks in the vibrant Young Engineers Forum (YEF). We are planning to have regular talks in YEF series, which will be both educative to all members as well as be a mentoring platform for our young members. In the next month, we are planning our first technical event of the year in the academic stream with programmes involving both theory and demonstrations. Activities in the student chapters are also to be revived as soon as the regular classes are resumed in colleges. Later in the year, we shall plan and organise our SENDAM 2022 conference. The Chairman and the Secretary have been regularly attending the National Governing Council (NGC) meetings and the Chairmen's meet of ISNT. Our activities and plans are being reported to the national body and the information relevant to our chapter shall be reported to our executive committee. The national AGM is scheduled in the end of December 2021. We shall strive to continue good, mutually beneficial interactions with the national body as well as our regional chapters. Since the technical interactions are now mostly in the webinar mode, combined programmes with neighbouring chapters also are being considered.

The year 2021 was a year of mixed feelings and emotions. As we continue to fight against the challenges, let us hope and pray that the New Year 2022 shall be a happy, healthy and prosperous one. Let me wish all of you and family members a wonderful and purposeful new year 2022.

Dr. Mohan Kumar L,
Chairman,
ISNT, Thiruvananthapuram Chapter.

New in this edition:

The Back-benchers' Quiz: Revisit NDE basics with the refresher quiz. The newest addition in the IMAGE newsletter aims to enhance or review the readers' knowledge of NDE.

The Bookworm's Corner: From the Editor's table, a novel column for the technical enthusiast introduces latest and relevant research in NDE in a crisp and stylish form.

Secretary's Report
(August - December 2021)

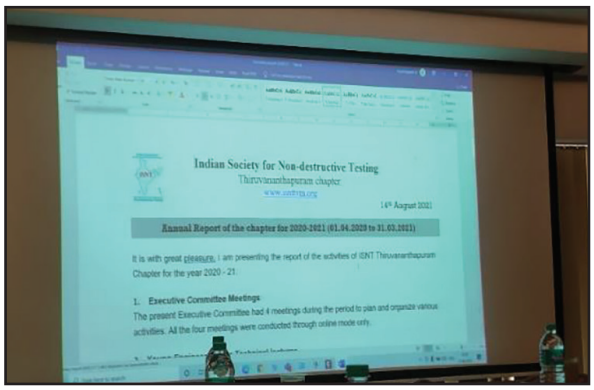
Shri. Girish N Namboodiri.
Secretary,
ISNT Thiruvananthapuram Chapter

During the period, Annual General Body Meeting (2020-21) was conducted on 14th August 2021 in hybrid mode. Past Chairman and Vice Chairman of ISNT, Thiruvananthapuram Chapter were felicitated during the event. New Executive Committee for the year 2021-23 was elected and took charge on the same day. First Executive Committee meeting with incoming and outgoing EC members was conducted on 04th September 2021 and the future activities of the chapter were discussed. Newly formed Young Engineers Forum (YEF) conducted lectures on 27th October 2021 through online mode. Lectures were delivered by Dr. Anil Kumar V, VSSC and Shri. Subash N N, SCTIMST, Thiruvananthapuram, and were attended by 50 participants. Chapter activity updates were sent to ISNT Head Quarters for discussion in the Chapter Chairmen's meeting and our Chairman, Dr. Mohan kumar L presented the same to the committee. Our Chapter members have actively participated in NDE 2021 Pre-conference Tutorials held on 03rd & 04th Dec 2021 followed by National Conference held on 09th to 11th December 2021 in which 11 technical papers were presented. Former Chairman of our chapter, Dr. Arumugam M chaired one of the sessions on Computed Tomography. Shri. Subash N N has joined as a Life Member of the chapter.

M R KURUP MEMORIAL LECTURE AND ANNUAL GENERAL BODY MEETING 2020 - 2021

M R Kurup memorial lecture was delivered by Shri. S Saratchandran, DD, VSSC on 12th August 2021 through online mode ahead of the Annual General Body Meeting (AGM). The AGM for the year 2020-2021 was conducted on 14th August 2021 through hybrid mode due to Covid-19 related restrictions. Past Chairman, Dr. Arumugam M welcomed all the members to the AGM. In the AGM, the Thiruvananthapuram Chapter felicitated its Past Chairman and Vice Chairman on their successful career at ISRO and on new responsibilities. Shri. Saratchandran S., Former Chairman / Former Deputy Director, VSSC was felicitated by Shri. G. Levin. Shri. K.S. Narayanan, Former Vice Chairman / Former Group Director, VSSC was felicitated by Shri. Saratchandran S. Both were felicitated for their immense contributions to ISNT during their tenures as Chairman / Vice Chairman and for their successful career in ISRO. All members wished them a happy, peaceful, and healthy retired life. The Chapter also requested their continued support to all forthcoming ISNT activities. Shri. G. Levin, Former Chairman and Former Deputy Director, VSSC was felicitated by Shri. K.S. Narayanan on assuming the new responsibility as Project Director, Space Park, Government of Kerala, Thiruvananthapuram. Past Secretary, Shri. Shunmugavel A presented the Minutes of last AGM and Secretary report. Dr. P Sasikumar, Treasurer, presented the audited statement of accounts for the year 2020-21. AGM discussed and approved both the annual report and the audited statement. One hundred and one (101) members attended the AGM both offline and online. New Executive members were proposed for the period 2021-2023 and AGM approved the same. New committee assumed charge and on behalf of the new committee, Chairman Dr. Mohankumar L thanked the AGM and previous Executive Committee for the opportunity and responsibility entrusted upon them. He briefed on the plans for the new team and solicited the cooperation of all the members for continuing the excellent work conducted by the past team. Shri. Girish N Namboodiri, Secretary, proposed the vote of thanks.

Glimpses of AGM



Annual Report presentation

Chairman, Dr. Arumugam M addressing the EC members

Past and Current Executive members of ISNT Thiruvananthapuram Chapter

Felicitation of Shri. Saratchandran S, former Chairman, ISNT Thiruvananthapuram Chapter

Felicitation of Shri. K S Narayanan, former Vice Chairman of ISNT Thiruvananthapuram Chapter

Felicitation of Shri. G Levin, former Chairman, ISNT Thiruvananthapuram Chapter

Shri. Saratchandran S delivering the M R Kurup Memorial Lecture through online mode

Executive Committee Members for the year 2021-2023		
Sl. No.	Post	Candidate (Shri. / Smt. / Dr.)
1	Chairman	Mohankumar L, VSSC
2	Vice Chairmen	Roykuttan KK, LPSC Jeby Philip, VSSC
3	Secretary	Girish N Namboodiri, VSSC
4	Joint Secretary	Binu B, VSSC Manu Joseph, LPSC
5	Treasurer	Sasikumar P, VSSC
6	Joint Treasurer	Karthikeyan P, VSSC`
7	EC members	1. Annamala Pillai S, VSSC (Retd.) 2. Sridhar S, VSSC 3. Nallaperumal M, VSSC 4. Gopakumar PN, VSSC 5. Harikrishna S, VSSC 6. Raju G, VSSC 7. Ratheesh S, VSSC 8. Sasi N, CET 9. Remakanthan S, VSSC 10. Rekha KR, LPSC 11. Anish Kumar, VSSC
8	Ex-officio	1. Arumugam M, LPSC (Immediate past Chairman) 2. Shunmugavel A, VSSC (Immediate past Secretary)
9	Advisors to EC (Permanent Invitees)	1. Levin G, VSSC (Retd.) 2. Sivasubrahmonian B, Mohandas College, Academic & Student Chapters

YOUNG ENGINEERS FORUM

The Young Engineers Forum organized two technical lectures through webinar mode on the Microsoft Teams platform on 27th October 2021 from 6.30PM to 8.30PM.

Lecture 1:

Additive Manufacturing for Space Applications

Speaker:
Dr. V Anil Kumar
Sci/ Engr-SF, MME/VSSC

The talk covered an introduction to additive manufacturing (AM), its potentials in the space industry, product development cycle aspects, quality control aspects, a few case studies, and its future trends.

The speaker explained in detail the various metal additive manufacturing methods such as laser powder bed fusion, electron beam powder bed fusion, directed energy deposition & electron beam additive manufacturing with short video clips and a quick, crisp, and informative comparison. He also stressed on the role of Design for Additive Manufacturing (DfAM) and Topology Optimization in weight reduction of systems and/

or part count reduction which is the need of the hour for effectively utilizing the capabilities of this technology.

On the aspect of quality control of AM components, he covered the various AM standards available such as the AWS D20.1, ASTM and AMS standards and shared the datasheets for different alloys. He stressed the need for reliable in-process monitoring of the AM processes and reliable NDT inspection techniques for confidently inducting the components for any application.

He provided a glimpse of the world scenario on metal additive manufacturing and spoke about the relevance of the same in the Indian scenario (especially the Space program). He also presented a few case studies on realization of various components of which some have successfully been inducted into the Indian Space program. He ended his talk with the future trends in the metal additive manufacturing industry.

The talk was followed by an interactive question & answer session.

Lecture 2:

NDE for QA/QC of biomedical applications such as high-risk implants

Speaker:
Shri. Subash N N,
Scientist, Medical Device Engineering, SCTIMST

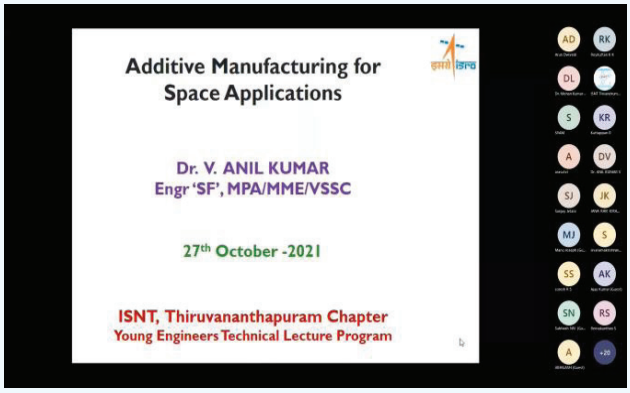
SCTIMST Ecosystem: SCTIMST, an institute of national importance, was established by an Act of Indian Parliament and under the administrative control of the Department of Science and Technology, Government of India. SCTIMST has three wings: a tertiary referral super specialty hospital, a biomedical technology wing and the Achutha Menon Centre for Health Science Studies. During the past three decades, the Institute has successfully developed many medical devices like artificial heart valve, hydrocephalus shunt, vascular graft, bio ceramic implants etc.

Medical Implants and NDE:

Beyond a certain stage of failure, it is effective to replace a malfunctioning organ than to seek in vain to cure it. Such functional disabilities can be addressed in two ways: implantation of prosthetic devices and transplantation of prosthetic devices. Some of the major problems associated with metallic implants are incompatible tissue/ implant properties, implants loosen with time, and requirement of revision surgery. Based on guidelines of Drugs Controller General, India and Global Harmonization Task Force-GHTF, medical devices are classified into Class A, B, C and D. High-risk implants such as heart valves and coronary stent come under class D category. NDE for design, material and process qualification is essential for avoiding surprises and adverse events during animal studies and clinical trials.

Way ahead and challenges:

The areas of paramount importance in NDE for medical implants includes safe service life assessment, deciding whether the defect footprint is fatal enough, NDE for new materials, coating, and manufacturing process.



Lecture by Dr. Anil Kumar V, VSSC

Lecture by Shri. Subash N N, SCTIMST

Technical Paper from the Chapter

TRANSMISSION BASED ULTRASONIC BOND TESTING OF CFRP TUBE TO METALLIC END FITTINGS

S. Hari Krishna[1], S. Sridhar[1], KM Usha[2], CR Bijudas[3], H. Priyadarshan[4], A. Rajarajan[1]

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2. Department of Biotechnology and Biochemical Engineering, Mohandas College of Engineering and Technology, Thiruvananthapuram, Kerala, India

3. Department of Aerospace Engineering, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India

4. Department of Avionics, Indian Institute of Space Science and Technology, Thiruvananthapuram, Kerala, India

Harikrishna S,
Life Member

Introduction

In the space and transportation sectors, composite tubes made of carbon fibre reinforced plastics (CFRP) are used because of their weight advantage over metals. Properties of these tubes are a function of the resin & fiber system; orientation & volume fraction (i.e. proportion) of fibers and manufacturing methods. Properties can easily be tailored to meet the requirements for specific applications.

For integration with other tubes/parts, the composite tubes can be either bonded or mechanically fastened. Bonding is preferred over mechanical fastening wherever possible. However, it requires tight control of bonding process and proper evaluation. Information provided by NDT after the bonding process; detection of the onset/ growth of disbond(s) if any, at different stages of qualification/acceptance tests plays a major role in product quality assurance.

Ultrasonic pulse echo testing is one option for NDT of the bond interface. However, this technique cannot be used if either bond interface echo or the echo from the total thickness of bonded joint cannot be obtained. Such a situation can arise due to tubes with lower levels of compaction. Usage of low frequency ultrasonics in pitch catch mode is another option. Other options include thermography and laser shearography.

In this paper an alternate approach for bond testing based on ultrasonic transmission-based technique is explained. Comparison of the results is done with those obtained by the low frequency ultrasonics in the pitch catch mode. Ultrasonic pulse-echo testing could not be used for the tube joint evaluation as the interface echo could not be obtained because of lower compaction levels of tubes, which are oven cured. Pulsed thermography and laser shearography using thermal excitation also could not detect the defects in these joints because of lower compaction levels, higher curvature and higher thickness of the tubes.

1. Tube to end fitting joint configuration and theory of defect detection

A typical joint between CFRP tube (Figure 1 right) to an Aluminium metallic end fitting (Figure 1 left) is chosen for the studies. Schematic of joint configuration is shown in Figure 2.

1.1. Low frequency ultrasonic pitch-catch technique

In the pitch-catch technique, one probe transmits (pitches) a burst of acoustic energy into the test part and a second probe receives (catches) the transmitted energy through the test part [7]. Bond condition beneath the two transducer tips

Figure 1. Photographs of CFRP tube (right) and metallic end fitting (left)

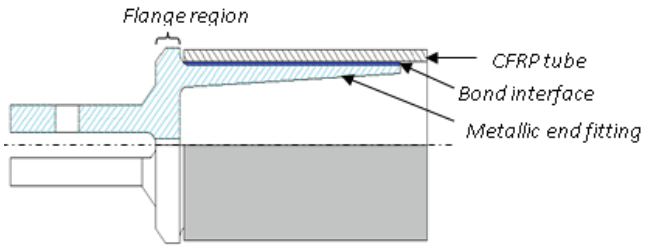


Figure 2. Schematic of tube to end fitting joint configuration

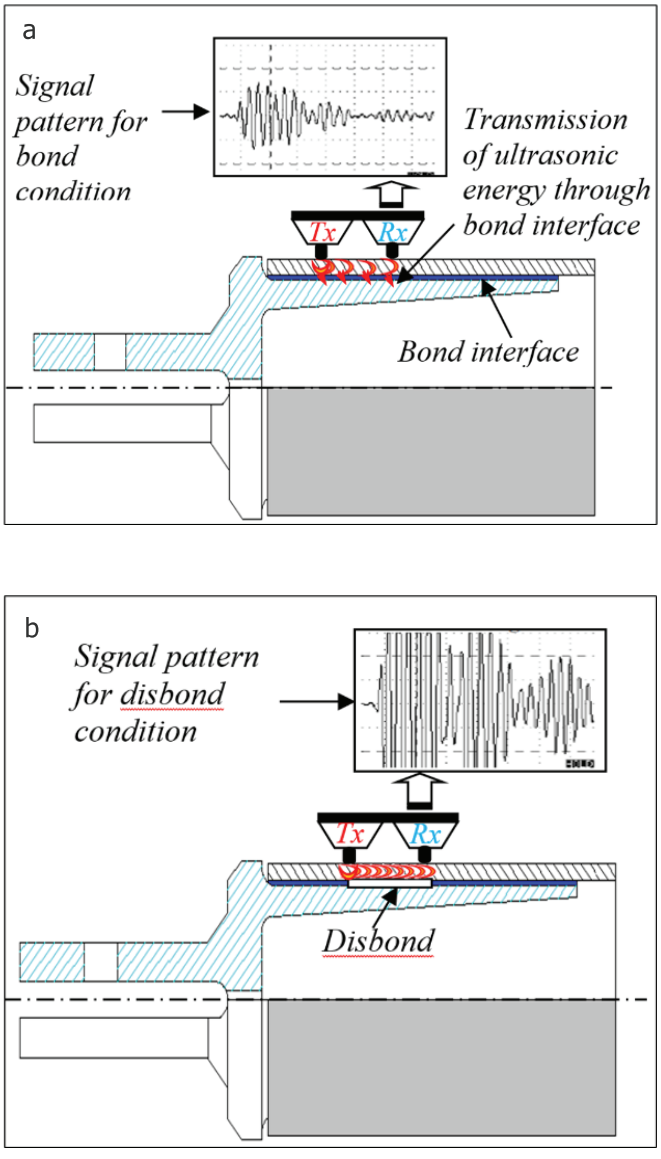


Figure 3. Defect detection principle of pitch catch technique (a) bonded condition and (b) with dis-bond

affects the characteristics of acoustic energy that is transmitted between the tips. These characteristics can be displayed in terms of phase and/or amplitude.

The relative amplitudes of the signals are a function of the impedance mismatch at the bond interfaces. For a bond condition, a portion of the acoustic energy transmitted into the tube is attenuated at the bond interface, resulting in a lower signal energy transmission to the receiver (Figure 3a). In a disbond condition, the transmission through bond interface is less because of higher impedance mismatch between tube and air interface, resulting in the higher acoustic energy transmission to the receiver (Figure 3b).

1.2. Ultrasonic transmission technique

In the proposed transmission technique, the transmitter is placed on the flange region of a metallic fitting and the receiver is placed on the surface of the composite tube, as shown in Figure 4. The transmitted ultrasonic waves are guided along the metallic end fitting. At the tube to end fitting interface, a portion of these guided waves are transmitted (or leaked) into the CFRP tube in case of bond, as shown in Figure 4a. The transmission levels come down in case of disbond, as shown in Figure 4b. Received signal is displayed on the monitor of ultrasonic equipment.

The signal consists of many peaks which correspond to the multiple modes of guided waves, which cannot be easily resolved. However, based on the total energy (i.e. envelope) of received signal rather than a single peak, comparison and distinction between good and disbond regions is made.

2. Experimental details

The CFRP tubes used in the studies were made of 28 number of uni-directional carbon prepreg

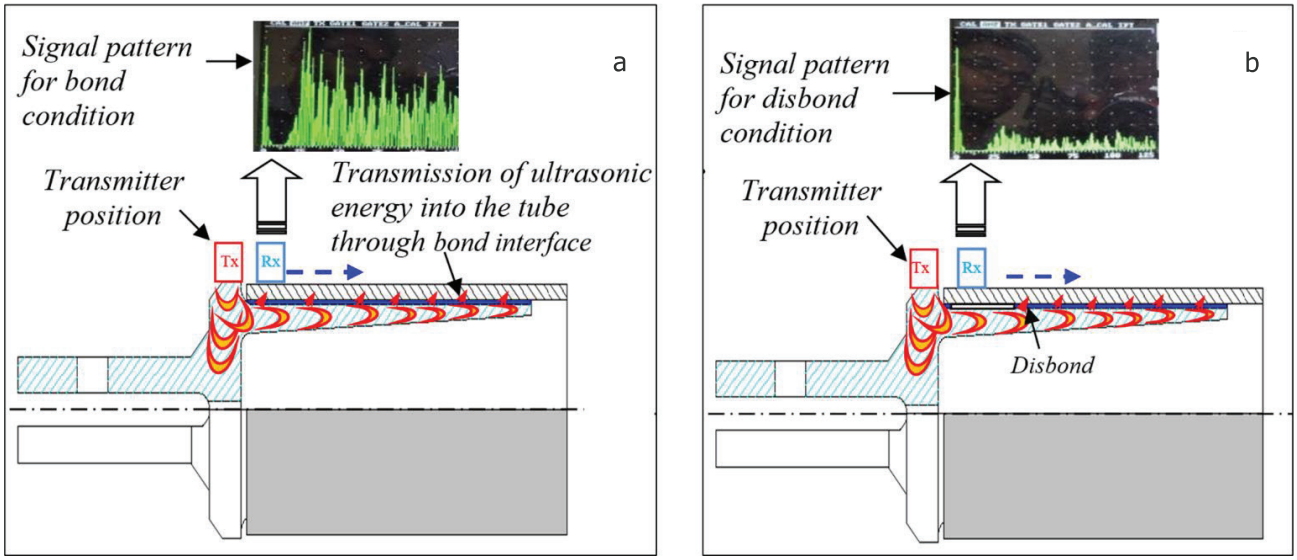


Figure 4. Defect detection principle of Transmission technique (a) bonded condition and (b) with disbond

layers rolled over a metallic mandrel, layer by layer. After the final prepreg layer, a plastic film is overwrapped; and final consolidation is done by a dry Kevlar hoop layer. After consolidation, the tubes are oven cured. The tubes (Figure 1) have a nominal diameter of 40 mm and thickness of 3.5 mm.

For the disbond detection studies, two numbers of the tubes are bonded with Aluminium end fittings

Table 1. Defect types

Tube No	Type of defect	Creation method
1	Partial disbond	No application of Araldite at a location
2	Full disbond with interference type of fit (kissing disbond)	Initially both end fittings were bonded. Afterwards, the tube was pull tested. The pulled-out end fitting was then reinserted (by force) creating interference type of fit.

(Figure 1) on either side of them using Araldite. Two types of interface defects are planned. Table 1 gives defect types and their creation methods.

For pitch-catch testing, Bond Tester S-21R from M/s Zetec, US is used. The probe used consists of two plastic tipped piezoelectric transducers separated by ½ inch. With a nominal frequency of 25 kHz and point tipped plastic probes in pitch-catch mode, the waves that propagate through the tubes are plate (Lamb) waves for disbond detection. The test parameters are fine tuned to get a maximum difference between bond and disbond conditions. The interface areas of all four metallic end fittings are tested with the optimum settings.

For the transmission testing, Dryscan 410D equipment from M/s Sonatest PLC, UK and two numbers of ¼" (0.25 inch) diameter, 5 MHz frequency probes from M/s Olympus, US are used. Probe selection is primarily guided by the curvature of the tube and the probe seating area available on the metallic end fitting. Vacuum grease is used for coupling the transmitter to the metallic end fitting. Silicone rubber is used for the dry coupling of the receiver for placing on the tube surface.

Subsequently, trials are carried out by varying different receiver filter frequencies. Optimum filter frequency is observed to be 1 MHz for the chosen combination of probes. Lower filter frequencies of 0.25 and 0.5 MHz could not distinguish the interference type of defects whereas higher frequencies of 2.25 MHz and above had very high attenuation of the signal.

For bond interface assessment, transmitter is placed at a location on the flange portion of metallic end fitting. Receiver is moved along the axial direction on the surface of tube. By moving the

transmitter around the circumference of the flange portion, the entire tube surface corresponding to bond interface area is covered. As the separation distance between transmitter and receiver is increased, reduced signal amplitude envelope is observed, because of higher attenuation. This factor is accounted for, for comparison of signals between bond and disbond locations.

3. Results and discussion

3.1. Tube with partial disbond

Pitch catch method using Bond Tester could distinguish the bond and disbond locations. Typical signals obtained at bond and disbond locations are shown in Figure 5a and b. The transmission method also could distinguish the disbond location (Figure 5c and d). Defect areas mapped by both methods matched within 1mm, which is acceptable because of manual mode testing.

identified as defective. The total area identified as defective by this method amounts to nearly 8% of the interface area. After reinserting pulled out end fitting back into the tube, these small areas might have sufficient gap/clearance that could be detected by this method.

3.2. Tube with kissing disbond

Transmission method could clearly distinguish the difference between the two end fittings (Figure 6). Entire tube surface corresponding to the kissing disbond interface could be mapped by this method. It can be seen that both methods use guided waves. In the pitch catch method, two transducers, which are separated by a fixed distance are used to test the bond condition, by placing them on the surface of the tube. Variation in the energy reflected from the bond interface is used for defect detection. In the transmission method, one transducer is placed on the metallic end fitting; the second transducer is placed on the surface of the tube. Distance

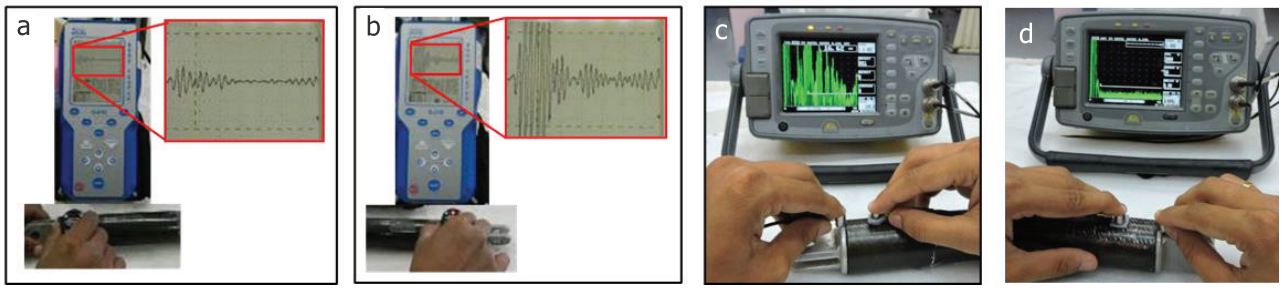


Figure 5. Results on partial disbond tube using pitch catch method on (a) bonded and (b) disbonded conditions. Results on partial disbond using transmission method (c) bonded and (d) disbonded conditions.

In pitch catch technique (Figure 6), no disbond indications could be obtained in the entire interface area of the kissing disbond except at two smaller portions. Figure 6b shows the signals obtained in the kissing disbond area. The area hatched in white is the disbond area, and within this area, a small portion denoted by red boundary is an area

between the two transducers is varied till the bond area is covered. Defect detection is by the variation in energy transmitted across the bond interface, while accounting the attenuation factor due to separation distance between the transducers.

Increased sensitivity of transmission method is

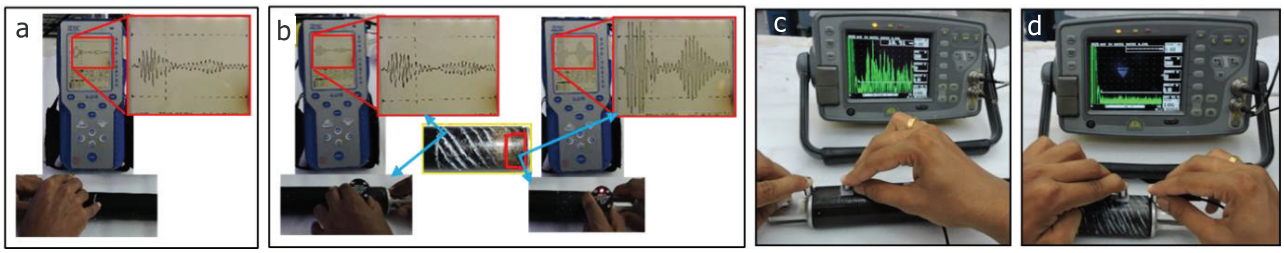


Figure 6. Results on kissing disbond tube using pitch catch method (a) bonded and (b) disbonded. Results on kissing disbond tube using transmission method (c) bonded and (d) disbonded.

due to the higher frequency of ultrasonic waves used compared to that of pitch catch method. Considering tube thickness, increase of frequency in pitch catch method cannot be done, as it makes the plates waves as surface waves, which cannot be used for bond interface evaluation. Transmission technique allows use of higher frequencies, whose upper limit is decided by the attenuation factor.

4. Conclusions

The proposed transmission based ultrasonic testing could detect disbonds in the interface of CFRP tube to metallic end fittings. While other standard NDT methods had limitations, this method is able to distinguish the kissing disbond simulated between tube to end fitting.

THE BOOKWORM'S CORNER

Brings you glimpses of latest research in NDE in a crisp and concise manner and discusses its relevance

Name of the article: ***Automated Defect Recognition on X-ray Radiographs of Solid Propellant using Deep Learning Based Convolutional Neural Networks***

Journal: Journal of Nondestructive Evaluation

Authors: Dhruv Gamdha, Sreedhar Unnikrishnakurup, K. J. Jyothir Rose, M. Surekha, Padma Purushothaman, Bikash Ghose, Krishnan Balasubramaniam

Publisher: Springer Nature, January 2021

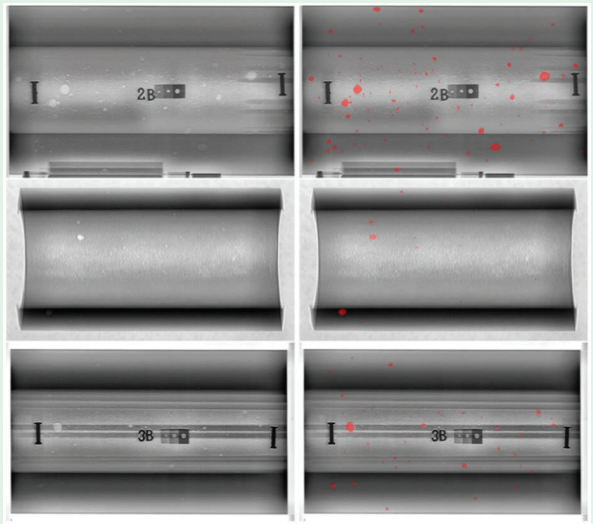
Link:https://doi.org/10.1007/s10921-021-00750-4

Shri. Manu Joseph
Editorial Team

Summary: The authors of this paper have successfully achieved Automatic Defect Recognition (ADR) of voids in X-ray radiographs of solid propellants using the Mask Region based Convolutional Neural Network (Mask R-CNN). The authors used an exhaustive dataset which consisted of over 400 experimental radiographs and over 1500 simulated images of defective propellant grains for training the Mask R-CNN.

The simulated images were obtained from CAD based ray tracing models with void type defects inserted in the CAD to simulate defects. Special care was also taken to ensure that the simulated images were as real as possible by adding noise to each image. The noise mask for this purpose was generated from carefully proctored experimental data by accommodating the effects of unsharpness and scattered radiation. An image from the paper is shown on the right which depicts that the AI approach proposed in the paper has performed ADR with 87% efficiency.

Relevance: NDE 4.0 looks to utilize the modern-day tools of Big Data, Artificial Intelligence (AI), Cloud functionality, the Internet of Things (IoT) and the concept of Blockchain to create a vast database of trustworthy and traceable data that can be quickly assessed thereby assisting the decision-making process. The above paper is an excellent example how this end is being achieved. With the availability of AI for ADR, large datasets can be used for effective training and implementation for qualification of radiographs, thereby reducing the effects of operator fatigue and inspection downtime



Real X-ray radiographs of solid propellant grains with voids given to the Mask RCNN for defect detection

ADR (red segments) through Mask RCNN by training with exhaustive dataset of simulated and real radiographs (over 2000)

THE BACK-BENCHERS' QUIZ

This section features 10 basic questions on NDE in the multiple-choice format for the members to brush-up their basics. The answers are provided at the end.

Shri. Anish Kumar
Editorial Team

1. Which of the following is not a non-destructive method to measure residual stress in the material?
   a. X-ray diffraction method
   b. Neutron diffraction method
   c. Hole drilling strain gauge method
   b. Ultrasonic testing

2. Where geometry permits in weld inspection, the distance you need to move the probe back from the weld to ensure 100% volume inspection is
   a. ½ skip from the weld centre line
   b. 1 skip from the weld centre line
   c. 1 ½ skip from the weld centre line
   d. 1 skip from the HAZ edge

3. Probably the most basic inspection technique is visual testing. Which of these items would a visual inspector, most likely, not use to carry out his duties?
   a. Rubber mallet
   b. Magnifying glass
   c. Flashlight
   d. Measuring devices

4. The trained industrial radiographer places a slice of film behind an item under test and exposes the specimen to strong x-rays to see inside the item. Which of the following isotopes are most used in industrial radiography?
   a. Strontium 90
   b. Iridium 192
   c. Polonium 210
   d. Thallium 204

5. Penetrant testing, or PT, is a surface NDE technique where a dye is applied to a welded item. If any defects, such as cracks or pinholes are present that are open to surface, the dye will seep into the defect. Which term best describes why the dye seeps into a defect?
   a. Hydraulic action
   b. Suction
   c. Osmosis
   d. Capillary action

6. Magnetic particle testing, or MT, is a surface NDE technique used on welds. Magnetic fields are induced, and then metallic flakes are applied onto the weld. If there are any breaks in the magnetic field due to a defect, the metal flakes will accumulate on it. Which of these items might be inspected utilizing the MT inspection techniques?
   a. Cast iron forgings
   b. Extruded plastic fittings
   c. Stainless steel piping welds
   d. Ceramic lined ball bearings

7. Becoming a non-destructive testing technician requires a firm understanding of physics, chemistry, metallurgy, and mathematics. Because clients are paying you to inspect their critical items, which would be another prime characteristic of the NDT inspector?
   a. Understand scientific formulas
   b. Ethics
   c. Remember long series of numbers
   d. Ability to drive large trucks

8. Who would be the ideal candidate for a position in the field of non-destructive testing?
   a. A welder working in a fabrication shop.
   b. A person studying chemistry in a university.
   c. Any of the above would be a suitable candidate.
   d. A person experienced in assembling objects in a factory setting.

9. Industrial ultrasound can be used as an imaging solution to see inside an item. What is the name of the device that the inspector uses to scan across a surface to see what's inside?
   a. Sonic manipulator
   b. Imaging head
   c. Flux capacitor
   d. Transducer

10. Which of the following is related to reliability of NDT techniques?
    a. Probability of Detection (POD)
    b. Six Sigma
    c. 80-20 or Pareto analysis
    d. Kaizen

Answers: 1c, 2d, 3b, 4b, 5d, 6a, 7b, 8c, 9d, 10a

Editor's message

Dr M Nallaperumal

Dear ISNT fellow members,

Our much-awaited IMAGE is here, and we have taken tremendous strides to bring you this issue filled with information and inspiration as intended. We encountered unforeseen challenges which we endeavored to overcome and continue unabated. A positive lesson of the pandemic is that concerted actions are possible at an incredible global scale.

As ISNT members, we know NDE is an amalgam of three inseparable aspects: Methods, Instruments and Intelligence. IMAGE is a platform where the intelligent people can communicate with one another about the above three aspects. The young vibrant team has come out with interesting articles in this issue. The overall activities of ISNT Thiruvananthapuram Chapter (from August to December 2021) have been summarized by the Chairman, Dr Mohankumar L and Secretary, Shri Girish N Namboodiri. The interesting lectures in the Young Engineers Forum by Dr Anilkumar V and Shri. Subash N N have been given in a nutshell.

A technical paper by Shri. Harikrishna S et. al. has been published in full, so that innovative methods developed by the team can be further explored.

We are happy to announce two new features, "The Back-Benchers' Quiz" and "The Bookworm's Corner" which is sure to make the reading more interesting. Shri. Manu Joseph and Shri. Anish Kumar are the men behind these features.

As the festivity of the season begins, we, the Editorial Team, would like to urge all of you to be safe and responsible as always.

Wishing you all a Happy and Safe New Year 2022.

For & on behalf of the team "IMAGE"

Dr M Nallaperumal
Chief Editor.


Indian Society for
ISNT
Non-Destructive Testing

Image

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