IMAGE

TECHNICAL BULLETIN OF INDIAN SOCIETY FOR NON-DESTRUCTIVE TESTING (ISNT)
THIRUVANANTHAPURAM CHAPTER

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From Chairman's Desk ...

Dear Members,

At the outset, let me extend all the chapter members a happy, healthy and eventful New Year greetings.

With all your cooperation, we had a successful and eventful year 2015. Many major tasks were accomplished in the previous year viz., technical talks organized by our dynamic young engineers' forum, a successful foundation course on NDT, very active participation in NDE 2015 etc. I am very much delighted to note that the efforts of our chapter members are recognized by ISNT and three of our members, Dr. S. Annamala Pillai, Shri. M. Arumugam and Shri. E. Sambamurthy are awarded at NDE 2015. My hearty congratulations to all of them.

I take this opportunity to announce that NGC of ISNT has entrusted the responsibility to host NDE 2016, to our chapter. As you are all aware, NDE seminar returns to Thiruvananthapuram after a gap of 13 years and many things have changed during this period including the scale and outreach of the grand annual event of ISNT.

I am extremely confident that with the active involvement and whole hearted support of all our beloved members of Thiruvananthapuram chapter, we together can make the event a grand success and a very memorable one to cherish for the future. At this juncture, I extend my sincere thanks and gratitude to all NGC members and fellow chapters of ISNT for their support. I should recollect the sustained solid support rendered by our immediate past president of ISNT, Shri. V. Pari and specifically place on record our very sincere gratitude to him.

Executive committee of Thiruvananthapuram chapter has started the preliminary work on NDE 2016. We are preparing for the first announcement of the conference and will be inaugurating the website soon. I urge each and every one of you to actively involve and contribute to make NDE 2016 a grand success.

Though NDE 2016 is going to be the major activity for the year, we shall ensure that our regular activities like workshops, technical lectures, IMAGE etc are accomplished without any slippage. I believe in the unbounded capabilities of our dynamic members.

Let me once again wish all members and their families a very happy and prosperous new year.

With best wishes

G.Levin
Chairman, Thiruvananthapuram Chapter

Dr. S. Annamala Pillai, Dy. Director (Retd.), VSSC and former chairman of ISNT Thiruvananthapuram chapter is conferred with 'Honorary Fellow of ISNT' during the National Seminar NDE 2015 at Hyderabad in November 2015.

Chapter Activities

FOUNDATION COURSE ON NDT

Chapter has organised a foundation course on NDT on 30th and 31st October 2015 at Hotel Classic Avenue,Thiruvananthapuram.The course was inaugurated by Dr. K Sivan, Director, VSSC and he released the course notes also. In his inaugural address he pointed out that ISNT chapters have a vital role for providing a floor to discuss and present the advancement and research work in the field of non destructive testing. He hoped that the course would provide knowledge and data on the fundamentals of NDT techniques being practiced. Shri. Levin.G, Chairman,ISNT Thiruvananthapuram chapter welcomed the dignitaries and delegates for the programme. In the welcome speech he mentioned about the upcoming activities of the chapter and appreciated all members for contributing their part in realizing the vision of the chapter. Shri. K. R. Mohan Ananthanarayanan, Course Director briefed about the details of course. Shri. Remakanthan S., Course Coordinator proposed vote of thanks. This was followed by invited lectures by experts from various field of NDT.

Welcome speech by Shri. Levin G.

Inaugural Address by Dr. K. Sivan, Director VSSC

Release of course note

About Course by Shri. K. R. Mohan Ananthanarayanan

View of Participants

Vote of thanks by Shri. S. Remakanthan

Following are the invited lectures

1. Introduction & Significance of NDT by Shri. S. Saratchandran, QRMG, VSSC
2. Radiography Techniques – Theory & Equipments by Shri. Karthikeyan P., CNDTD, VSSC
3. Advanced Radiography Techniques & Practices by Shri. Murugesan N., QNDTD, IPRC
4. Ultrasonic Inspection – Theory & Instruments by Shri.L Raju,MME, VSSC
5. Infrared Thermography by Shri. S. Sridhar, CSED, VSSC
6. Ultrasonic Inspection – Applications & Advances by Shri. M. Arumugam, QCIG, LPSC
7. NDT of Propellantsby Shri. Cherian Thomas, NDTD, VSSC
8. NDT of Composites by Shri. Harikrishna, CNDTD, VSSC
9. Acousto Ultrasonics byShri.VKRavindran,SR,VSSC
10. Optical Techniques of NDT- Fundamentals by Shri. Binu P Thomas, EXMD, VSSC
11. Acoustic emission by Shri. KK Purushothaman,EXMD,VSSC
12. Visual Techniques, codes and certification by Shri.KR Mohan Ananthanarayanan, VSSC

The lectures were followed by practical sessions on RT Film interpretation, Liquid penetrant test and Ultrasonic testing. Shri. Remakanthan S, NDTD, VSSC, Shri. G. Rajuand Shri. Rajesh. L, QIT, VSSC were the faculty for the practical session and they have shared their NDE experiences to all the participants. The course was attended by 69 delegates from different centers of ISRO and industries. The programme was well received and feedbacks on the lectures were that the course was very useful. The valedictory function was chaired by Shri. Saratchandran, Past chairman, ISNT Trivandrum chapter. Shri. Levin.G, Chairman,ISNT Trivandrum chapter & Shri. Saratchandran, GD, VSSC distributed the certificates of participation to the delegates and Shri. A. Shunmugavel, Secretary proposed vote of thanks.

Lecture Session

Practical Session

Issue of Certificate of Participation by Shri. S. Saratchandran

TECHNICAL TALK ON INFRARED THERMOGRAPHY

A technical talk was arranged on 14th October 2015 by Young Engineers' Forum of ISNT on "State of the art Thermal / Infrared NDT & E for detection of sub-surface defects and their properties" at Hotel Nandanam Park, Trivandrum. The talk was delivered by Dr. Ravibabu Mulaveesala, Assistant Professor, Department of Electrical Engineering, Indian Institute of Technology, Ropar, a well renowned figure in the field of thermography.

Dr.Ravibabu giving the lecture

Welcome address by Shri.G.Levin

Shri. G. Levin, Chairman, ISNT Thiruvananthapuram welcomed Dr. Ravibabu and thanked him for his time and efforts. Shri. Harikrishna, Coordinator, Young Engineers' Forum introduced the speaker. Dr. Ravibabu, in his talk, cited many original research advancements from his own and his team's work on infrared thermography. The talk was highly interactive and well appreciated by people working in the field of thermography as well as other members. Around 50 members attended the talk. Dr. Annmalai Pillai, Hon. Fellow, ISNT, presented a memento to Dr. Ravibabu. Shri. A.Shunmugavel, Secretary proposed vote of thanks. The talk was followed by dinner.

A view of audience

Dr. S. Annmala Pillai handing over the memento

Secretary's Report

Inside EC

- Three EC meetings were held (14th October, 3rd December & 21st December 2015)
- Readiness of Foundation course on NDT reviewed.
- Chapter diary is made ready and a few copies are distributed to EC members
- Proposal for NDE 2016 is prepared and reviewed
- Initial proposals for NDE 2016 local organising committee, venue details & themes are finalized
- Future programs planned are
  - a. One day workshop at Rajadhani Institute of Engineering & Technology
  - b. Felicitation of NDE 2015 awardees
  - c. Young engineers forum lecture on "Proof Pressure Testing" by Shri. Yezhil Arasu

NDE 2015

NDE 2015 was held from 26th to 28th, November, 2015 at Hyderabad International Convention centre and organized by ISNT Hyderabad Chapter. Chairman & Secretary of ISNT Thiruvananthapuram chapter attended NGC meeting on 25th November and presented the proposal for NDE 2016 at Trivandrum and NGC awarded the responsibility of hosting NDE 2016 to ISNT Thiruvananthapuram chapter.

Chapter members at NDE 2015

Dr. S. Annamala Pillai & Shri. M. Arumugam of our chapter were awarded Honorary Fellow & NDT excellence award for industrial applications of NDT respectively during inaugural function of NDE 2015. The awards were distributed by Shri. Sudhakar Reddy, Scientific Advisor to Defence Minister & Shri. Dinesh Kumar Likhi, CMD, MIDHANI.

A total of 13 delegates participated from Thiruvananthapuram chapter and many of them presented papers and posters. Shri. Sambamoorthy of our chapter received the best paper award. Our team visited all exhibition stalls and welcomed all exhibitors to NDE 2016.

NDE 2016

NGC of ISNT has accepted our proposal for hosting NDE 2016 in its meeting on 25th November 2015 and officially declared Thiruvananthapuram as next host chapter. Shri. Girish Namboodiri received the flag for NDE 2016 at the valedictory function held on 28th November 2015.

The conference, NDE 2016, is scheduled during the month of December, 2016 and the venue will be the sprawling, spacious and contemporarily styled Alsaj Convention Centre, Trivandrum.

New Members

Sl. No.	Name	Type of member	Organization
1	Sushant K. Manwatkar	Life Member	VSSC
2	Sudarshan Rao.G	Member	VSSC
3	Jayakrishnan KR	Life Member	VSSC
4	Ashis Kumar Samanta	Life Member	VSSC
5	Chandrashekhar Thiramdas	Life Member	Tomtec NDT, Singapore
6	Anish P. Kumar	Associate Member	VSSC (Contract)
7	Ajish Pratheep Kumar	Student Member	Student (Calicut University)
8	Rajeev Panda	Life Member	VSSC

Congratulations

NATIONAL NDT AWARD 2015

Shri. M.Arumugam was awarded NDT excellence award for industrial applications of NDT.

Shri.M. Arumugam graduated in Metallurgical Engineering from Government College of Engineering Salem (TN) in 1987 and obtained his MS from BITS, Pilani. After serving in Defence Production sector for a period of 4.5 years, he joined the Vikram Sarabhai Space Centre, Indian Space Research organization, Thiruvananthapuram in 1992. He has been working in the area of NDT and Qualification of Materials for Defence and Aerospace applications for the past 28 years. Currently he is the Group Head for Quality Control and Inspection Group of Systems Reliability and Quality Assurance Entity, Indian Space Research Organisation, LPSC, Thiruvananthapuram.

He has contributed immensely in generating and streamlining the NDT procedures and acceptance criteria for Titanium alloy & Maraging steel pressure vessels for solid and liquid propulsion systems, investment castings for Cryogenic propulsion systems and raw materials for satellite launch vehicle programme. He has been instrumental in implementing process improvements which resulted in achieving the highest ultrasonic quality level for larger size Aluminium alloy rings, massive size 15-5PH forgings for hypersonic wind tunnel and centre agitator shaft for 4.5T solid propellant mixer which were considered to be technological challenges. He was responsible for characterisation and precise sizing (through UT) of a crack detected in a solid booster casing (after propellant casting) which had given confidence for proceeding with the successful static test related to next generation satellite launch vehicle. He had successfully implemented phased array ultrasonic testing for fault detection & health monitoring of Maraging steel shear bolts assembled in GSLV-MKIII to take care of SCC cracking problem, enabled successful maiden flight. He had served as a specialist member in "BrahMos" missile Attestation committee for indigenisation of materials. In this capacity he had approved the Ultrasonic testing procedures for various strategic materials used in "BrahMos" missile.

He has 15 national and international publications to his credit and published over 50 technical reports in the field of NDT and metallurgy.

Congratulations

BEST ORAL PRESENTATION AWARD IN NDE 2015

Shri. Sambamurthy Enugula, NDTD/RPP/PRSO won the best oral presentation award for the paper "Digital processing of radiographic images of aerospace components for hidden feature extraction" presented in the 25th National Seminar & International Exhibition on Non-Destructive Evaluation (NDE - 2015), held at Hyderabad during November 26th to 28th, 2015. The paper was co-authored by Shri. R. Gunasekaran, Shri. Cherian Thomas and Shri. C. R. Thomas

DIGITAL PROCESSING OF RADIOGRAPHIC IMAGES OF AEROSPACE COMPONENTS FOR HIDDEN FEATURE EXTRACTION

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1. INTRODUCTION

Digital radiography (DR) has certain specific advantages over conventional film radiography. One such important advantage is that digital image is amenable for processing. A conventional radiographic film can be digitized and the Digital Image Processing (DIP) can be carried out. Image enhancement and information extraction are two important components in DIP. The DIP helps in maximizing the image clarity, sharpness and details of features of interest towards information extraction and further analysis.

There are different type of operations that can be carried out on an image viz point operations, local operations and global operations.

$$O(x, y) = H^*I(x, y)$$

Where O(x,y) is new output image

H is image processing operation carried out and

I(x,y) is original image

The present paper speaks on application of the DIP for extracting the features from a radiograph, which are not seen under normal conditions. Three cases were considered in this paper viz charge filled lead tube, Flexible Linear Shaped Charge (FLSC) and Explosive Transfer Assembly (ETA). In these cases DIP brings out the critical information such as integrity of explosive charge, proper distribution of charge and integrity of charge interfaces.

In the present study, frequency domain and spatial domain analysis has been carried out on radiographic images of Flexible Linear Shaped Charge (FLSC), charge filled lead tubes and Neutron radiographic images of Explosive transfer assembly (ETA).In each case different processing tools have been applied for getting the required information.

Critical information like asymmetrical charge distribution in FLSC, low density regions in charge filled lead tube, explosive charge column and interface gap between Booster charge and Conical charge in NR images of ETA etc. are clearly distinguishable through image processing.

This paper describes the various image processing techniques used and the case studies carried out using optimised techniques.

2 . EXPERIMENTAL DETAILS

All the radiographic images are scanned with the help of M/s GE make 16 bit digitizer with a scanning resolution of 50 Micron. All the images are saved in Tagged image file format (Tiff) for image processing. Image processing has been carried out by using Image J software, version 1.46. It is an open source digital image processing package.

3. RESULTS AND DISCUSSION

3.1. Charged filled lead tube

Explosive charge is filled in a lead tube and it is extruded to get the detonating cord of different linear charge densities. Any improper filling/distribution of the charge inside the lead results in defective cords which will have serious implication on performance of the system. Small unfilled regions/air gaps of width of the order 0.2 mm are noticed at times which are difficult to interpret on a normal radiograph. The extent of the defect also not clearly seen on a normal radiograph, with proper image processing these charge imperfections can be clearly seen.

Normal radiographic image of explosive filled lead tubes is shown in fig1. The basic image is darker hence the uniform addition of 40 gray values made the image brighter. Contrast enhancement has been carried out on the local area by histogram equalization. Contrast enhancement is required because there is a strong influence of the contrast ratio on resolution power and detection capabilities of the image. It is important to utilize the entire brightness range for optimum contrast ratio. Here histogram equalization is carried out in which the original histogram has been re distributed to produce a uniform population density of pixels along horizontal axis. With the localized contrast enhancement the details were seen very clearly as shown in fig2.

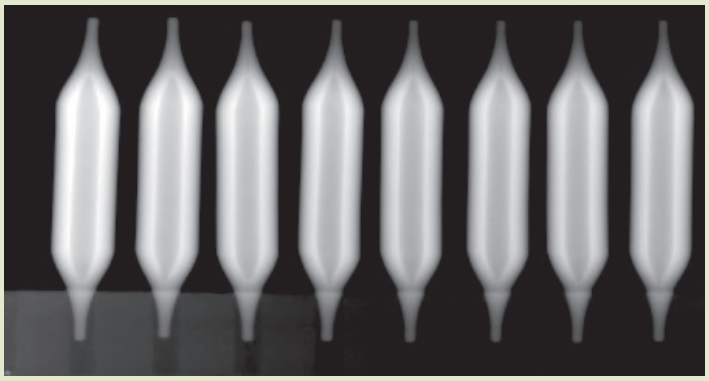

Fig1: Radiographic image of charge filled lead tube

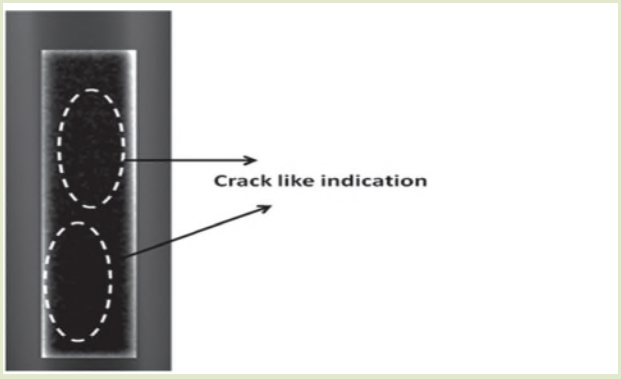

Fig2: Processed image of the lead tube

3.2. Improper charge distribution in FLSC

FLSC is a V shaped structure as shown in figure3 used for critical applications. It's shape is obtained by swaging operation on a cylindrical shaped tube. Proper charge distribution and apex thickness are essential for the successful performance of the FLSC. One of the FLSC did not perform satisfactorily in a ground test. When the preserved cut pieces of the failed FLSC and a good FLSC were radiographed and compared, they are identical and not showing any variation in charged region.

To carry out the frequency domain analysis FFT is applied. Low pass filtering is carried out. Because of low pass filtering high frequency noise is eliminated. An inverse FFT is carried out to bring the image to spatial domain. The image becomes smoother but it loses sharp contours and crisp edges. Edge detection has been carried out to find out the edges lost by smoothing during low pass filtering. Edge detection uses a Sobel edge detector to highlight sharp changes in intensity in the active image or selection. Two 3X3 convolution kernels are used to generate vertical and horizontal derivatives. The final image is produced by combining the two derivatives using the square root of the sum of the squares. Then contrast enhancement has been carried out for throughout the image by histogram equalization with 0.4% pixel saturation. The pixel saturation value should be greater than zero to prevent a few outlying pixels from causing the histogram stretch to not work as intended.

Fig3a.Radiographic image of normal FLSC

Fig3b. Radiographic image of defective FLSC

Fig4a.Procesed image of normal FLSC

Fig4b. Processed image of defective FLSC

In processed image of defective FLSC, the charge thickness and density of charge are not identical/symmetrical on both sides of the axis however charge thickness and density exactly symmetrical in normal FLSC.

3.3. Interface gap in ETA

ETA is mainly used to carry/maintain the detonation form one end to another end. Here the interface of the

booster charge and MDC charge is very critical. Any gap between these charges can alter the performance of the device. NR is carried out to see the charge details however it is very difficult to distinguish the gaps of size less than 0.3 mm. With the application of proper image processing tools it is possible to distinguish smaller gaps very clearly.

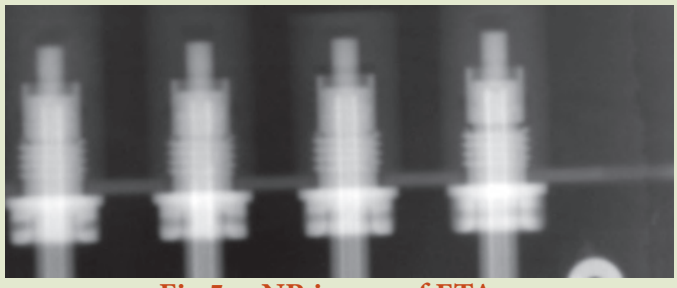

Fig 5a: NR image of ETA

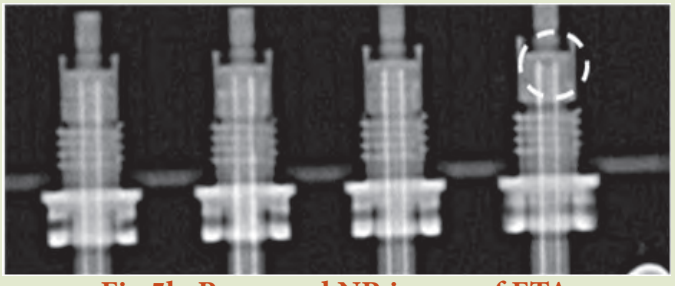

Fig 5b. Processed NR image of ETA

The overall sharpness of the image is less and hence to increase the sharpness of the image sharpen filter is applied. It Increases contrast and accentuates detail in the image or selection, but may also accentuate noise. This filter uses the following weighting factors to replace each pixel with a weighted average of the 3X3 neighbourhood

-1 -1 -1

-1 12 -1

-1 -1 -1

To eliminate the background noise, ‘’subtract background” operation is carried out. This operation uses the ‘rolling ball’ algorithm. A ball of given radius is rolled over the bottom side of this surface; the hull of the volume reachable by the ball is the background to be subtracted. Subtracting the background increases the image contrast.Finally the contrast enhancement carried out to get the image that shows the interface gap clearly. In processed image 0.5mm gap is noticed in one of the ETA (extreme right in the fig 5b) and it is indicated with dotted circle in fig 5b.No such interface gap is noticed in other images shown in the image.

4. CONCLUSION

Image processing is a useful tool in bringing out the hidden features in a normal radiograph. Systematic and sequential application of the proper DIP operations will give the required details. Minor crack like observations noticed in charge filled lead tube, improper charge distribution in FLSC & interface gaps in ETA were brought out clearly through image processing.

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