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Indian Welding Journal (ISSN 0046-9092) is the official journal of the Indian Institute of Welding (IIW-India) being published quarterly since 1968. Articles published in it are indexed by EBSCO- USA, Crossref - USA, i-Scholar, j-Gate and Indian Citation Index. Articles on welding and cutting are invited from prospective authors. This journal includes selected technical articles published in Welding Journal of American Welding Society. Article submission guidelines are available in www.iiwindia.com. Published articles may be found out through surfing the web page : http://www.ischolar.info/index.php/IWJ. Indian Welding Journal has also been figured out in the List of UGC approved journals in the year of 2017.


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**Prof. Dr. Santanu Das**
Chief Editor
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iwj.iiw@gmail.com

Within the intense hot condition, **Volume 57, No.2, April 2024 issue of Indian Welding Journal** is being published. Volume 57, No.1, January 2024 issue of Indian Welding Journal has been published before the International Congress of The International Institute of Welding (IC-2024) held at Bengaluru on January 22-25, 2024 and is available in the flip book format in the website of IIW-India, www.iiwindia.com. Anybody can read flip book version of this journal concerning welding, joining and cutting.

Reports of different activities arranged by Branches, Sections and Chapters of IIW-India are there in this issue. The articles of the Section sent by the American Welding Society (AWS) is there as usual as Indian Welding Journal is published with a technical association with AWS.

Under **"Tit Bit in Welding"** column, **Mr. S M Vaidya**, Advisor - Technical of Godrej and Boyce Mfg. Co. Ltd. has contributed few of his rich experiences with regard to welding fabrication related issues. Hope his notes will be of help to the industry people.

Details of the Contributory articles included in this issue are:

1) on **"CAD-to-Print Strategy for Gas Metal Arc Directed Energy Deposition**" by Birendra Kumar Barik, Prashant Kumar Chaurasia, Amitava De of the Department of Mechanical Engineering, Indian Institute of Technology Bombay,

2) on "**Resisting Corrosion under Chloride Environment by Providing Duplex Stainless Steel Cladding through FCAW"** by Bidhan Chandra Biswas, Anup Kumar Verma, Protap Roy, Samiran De, Sukanta Saren and Santanu Das of the Department of Mechanical Engineering, Kalyani Government Engineering College, Kalyani.

Apart from the above two articles from academia, there are two more Case Study articles being published in this issue, namely,

3) **"Fabrication of India's Largest, Welded Titanium Vessel"** authored by Avinash Abnave and Vivek Bhisade.

4) **"Welding of 24mm Thick Oxygen Free Copper Plates for Large Size Turbo-Generator"** by Avinash Abnave and Jaspal Sahu.

Prospective authors are invited to submit research articles, case studies, etc. for the Contributory article section, or for the column, "Tit Bit in Welding", following Author Guideline available in www.iiwindia.com. All the articles are to send to the Chief Editor through email (ID: iwj@iiwindia.com and iwj.iiw@gmail.com) both in MS-Word and pdf file format mentioning the ORCID number of each author.

The Chief Editor is pleased to announce that the full repository of Indian Welding Journal has been made available through another facility promoted by M/s. Informatics Publishing Private Limited, Bengaluru in addition to i-Scholar system as given below. Everybody is requested to please surf the archive of IWJ through the website, https://www.informaticsjournals.com/index.php/IWJ and https://www.i-scholar.in/index.php/IWJ. Abstracting of published articles is done by EBSCO-USA, Crossref-USA, Indian Citation Index (ICI), i-Scholar and j-Gate. This journal was also enlisted in the UGC approved list of journals in 2019.

Suggestions from the readers are requested for further improvement of the journal.

April 27, 2024

# BRANCH REPORTS

## BARODA BRANCH

### 6th International Congress (IC 2024)

Attended 6th IC 2024 on “Advancement through Sustainable and Green welding” at BIEC, Bangalore during 22nd to 24th January

Mr. S K Agrawal, Mr. Rajesh Madnani, Mr. Jignesh Patel, Mr. Hetal Parikh, Dr, Vishvesh Badheka, Dr. Kalyankar, Mr.Ritesh Patel, Mr. Prashant Barodia and Dr. Subhash Das were present and attended the IC.

### WELDEXPO (2024)

Attended WELDEXPO, Exhibition for welding, cutting and joining during January 19-23

Mr. S K Agrawal, Mr. Rajesh Madnani, Mr. Jignesh Patel, Mr. Hetal Parikh, Dr, Vishvesh Badheka, Dr. Kalyankar, Mr.Ritesh Patel, Mr. Prashant Barodia & Dr. Subhash Das were present and attended the WELDEXPO.

### Receiving Awards


Attended to receive Minati Bhattacharjee memorial award for the best performing branch 2022-23 during IC-2024 at BIEC, Bangalore during 19th to 22nd Jan 2024.

Mr. S K Agrawal, Mr. Rajesh Madnani, Mr. Jignesh Patel, Mr. Hetal Parikh, Dr. Vishvesh Badheka, Dr. Kalyankar, Mr. Ritesh Patel, Mr. Prashant Barodia & Dr. Subhash Das presented during award behalf of Baroda branch.

## BARODA BRANCH

### Council Meeting

Attended 335th Council meeting at BIEC, Banglore on 23rd January

Mr. Rajesh Madnani , Mr.Jignesh Patel and Mr. Hetal Parikh attended council meeting.

### IIW-ISNT Joint Program

On 07 February-2024, Indian Society for Non-Destructive Testing – Vadodara Chapter, The Indian Institute of Welding – Baroda Branch and Baroda Management Association had jointly organized an evening lecture on topic “Significant Advances in Surface NDT Methods” at Hotel Tarasuns, Vadodara.
Around 105 participants had attended the evening lecture.

## BARODA BRANCH


25th foundation day of IIW-India, Baroda branch is celebrated on 7th October 2023 at Hotel Marriott, Vadodara.
Theme was “Welding industry in India – Challenges and Application”. Total 100 participates took part in this event.


Branch level best welder competition held on 25th November at M/S.Anuptech, Baroda sponsored by Bohler India.
Total 31 participates took part including woman welder.

One day seminar on "Developments in Quality Management in the field of welding" organised by BIS in association with Baroda Branch
on 9th December at Hotel Express Towers, Vadodara. Total 75 participates took part in this event.

In house Welding Training program conducted at “Metallizing Equipment Co.Pvt. Ltd.”, Jodhpur, Rajasthan from 04-12-23
to 07-12-2023 through Mr. Prashant Barodia. Total 10 participates including welders, supervisors and engineers.
Training was on Basics of SMAW and GMAW process with practical hands on training.

## HYDERABAD BRANCH

### Webinars

There were no activities conducted during the period of January – March 2024.

### Other Activities

| Sl. No | Date | Subject | Description |
|---|---|---|---|
| 1 | 11-12 Jan. 24 | Workshop on "Advanced Welding Technologies in National Mission Programs (AWTNMP 2024)" | • **About AWTNMP 2024:**<br>The workshop on Advanced Welding Technologies in National Mission Programs (AWTNMP) was aimed to bring together, connect and collaborate among the scholars and faculty from the academia, engineers and scientists from the R&Ds and manufacturers from the above industries. The technical and industrial talks are scheduled in such a way that the key issues and challenges in the broad areas of materials, welding technologies and quality inspection techniques are discussed by the eminent researchers, which would immensely help in doing high quality research and services to the nation.<br>• **Hosts:**<br>▪ Indian Institute of Welding, Hyderabad Branch.<br>▪ Defence Research & Development Laboratory (DRDL), Hyderabad.<br>• **Venue:**<br>▪ Defence Research & Development Laboratory (DRDL), Hyderabad.<br>• **Dates:**<br>▪ January 11-12, 2024.<br>• **Conveners:**<br>▪ Dr. P. Mastanaiah, Scientist F, DRDL.<br>▪ Prof. Jeevan Jaidi, Honourable Secretary, IIW-Hyderabad Branch.<br>• **Organizing Committee:**<br>▪ MC members, IIW-Hyderabad Branch.<br>• **Invited Speakers:**<br>▪ Dr. G. Madhusudhan Reddy, Professor, NIT-Warangal.<br>▪ Prof. V. Balasubramanian, Annamalai University, Chidambaram.<br>▪ Shri. Challa Phani Babu, Dy. Chief Executive (Retd.), NFC, Hyderabad<br>▪ Dr. A. Manjunath, Scientist - G, GTRE, Bengaluru.<br>▪ Dr. S. Suresh, Former General Manager, WRI BHEL Trichy & CoE Welding PSG Tech., Coimbatore.<br>▪ Prof. Gopala Krishna, JNTU, Kakinada, A.P.<br>▪ Dr. Christ P. Paul, Scientist, RRCAT, Indore.<br>▪ Dr. B. Venkatraman, Director, IGCAR, Kalpakkam.<br>▪ Dr. CVS Murthy, Associate Director, DRDL, Hyderabad.<br>• **Registered participants:**<br>▪ More than 100 participants have registered from academia, R&Ds, private industries and national labs (DRDO, DAE and CSIR) across the country. |

## HYDERABAD BRANCH

AWTNMP 2024: Inaugural ceremony and lighting of the lamp by Shri G. A. Srinivasa Murthy, Director, DRD


AWTNMP 2024: Invited speakers (from right to left)
1. Dr. S. Suresh, Former General Manager, WRI, Trichy
2. Dr. Christ P. Paul, RRCAT, Indore
3. Dr. B. Venkatraman, Director, IGCAR, Kalpakkam

AWTNMP 2024:
Organizing committee members of DRDL and IIW-Hyderabad

AWTNMP 2024: Registered participants from academia, R&Ds, industries & DRDO labs

AWTNMP 2024 : Registered participants from Academia, R&Ds, Industries & DRDO labs

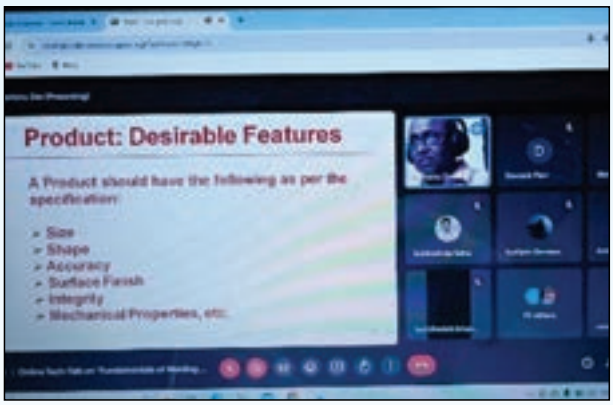
## COCHIN RANCH

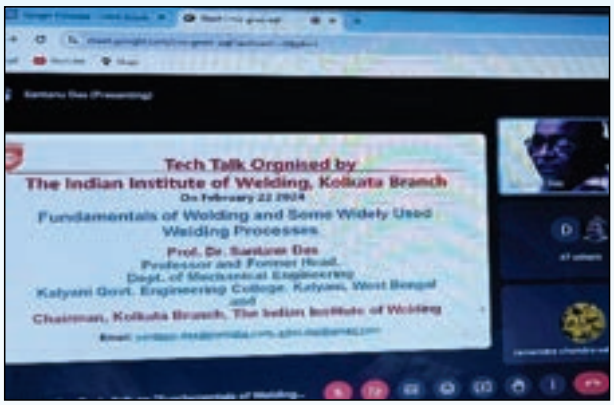
Mr. Sabarinth C Nair, Skillveri Training Solutions Private Ltd. is giving a technical presentation on Monday 26th Feb 2024 at 6pm on "mixed reality and extended reality in welding training - from India & the US"

## KOLKATA RANCH

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 1 | 17.02.2024 | Workshop on "Manual and Automated Arc Welding & Cutting" | The Workshop was organised by IIW-India Kolkata Branch for IIW-India's Students' Chapter, Institute of Engineering & Management, Salt Lake at M/s. NextGen Plasma Pvt. Ltd., an ICM under Kolkata Branch at their facility at Jagadishpur, Howrah. | Kolkata Branch along with IEM Students' Chapter. |

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 2 | 22.02.2024 | Webinar on "Fundamentals of Welding and some Widely used Welding Processes" | A Lecture was delivered by Prof. Santanu Das, Chairman, Kolkata Branch and Professor, Mechanical Engg, Dept., Kalyani Govt Engineering College, Kalyani on Feb. 22, 2024 at 7 pm Online, through Google Meet platform. The Webinar is mainly meant for Diploma and Btech students. | Online Webinar for the Students under Kolkata and West Bengal region (mainly). |



## KOLKATA RANCH

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 3 | 29.02.2024 | Seminar on Welding as a Profession for Emerging Engineers: | A Seminar has been arranged at Dasnagar Govt. Polytechnic, Dasnagar, Howrah on Welding as a Profession for Emerging Engineers. Prof. Santanu Das, Prof. T. K. Pal, Mr. Devasis Paul and Mr. Rituraj Bose of IIW-India, Kolkata Branch delivered their experience to the students in shaping their career growth in Welding | IIW-India Kolkata Branch and Dasnagar Govt. Polytechnic College, Dasnagar, Howrah. |

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 4 | 13.03.2024 | Seminar on "Challenges on Welding of Automotive Steels" | Inauguration of a New Students Chapter at Dr. Sudhir Chandra Sur Institute of Technology and Sports Complex, Dumdum, Kolkata by Prof. Santanu Das, Mr. Rituraj Bose & Prof. T. K. Pal. Prof. Santanu Das discussed about different important welding processes employed in fabrication of automobiles, while Prof. T. K. Pal delivered the lecture on "Challenges on welding of Automotive Steels". Mr. Rituraj Bose spoke on different career opportunities in welding and about activities of IIW-India. | IIW-India Kolkata Branch and Dasnagar Govt. Polytechnic College, Dasanagar, Howrah. |

## KOLKATA RANCH

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 5 | 29-30.03.24 | IIW-India, Kolkata Branch in association with Indian Institute of Metals (IIM) Kolkata Chapter organized a Conference on "Nonferrous Metals and Matyerial Science" | A Two-day International Conference on Non-ferrous Metals and Material Science 2024 organized by IIM, Kolkata Chapter held at Biswa Bangla Convention Centre, Kolkata along with IIW-India, Kolkata Branch. Chairman Prof. Santanu Das have been invited on the dias as Guest of Honour. IIW-India Kolkata Branch acted as a Knowledge Partner in this International Conference. Furthermore, Prof. G. L. Datta and Prof. T. K. Pal have delivered their lectures on 30th March, 2024. This session has been chaired by Prof. Santanu Das. | IIM-Kolkata Chapter in association with IIW-India Kolkata Branch at Biswa Bangla Convention Centre, Kolkata |

## MUMBAI RANCH

### Webinars & Seminars

| Sl. No. | Date | Subject | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|---|
| 1 | 3rd February 2024 | Paid Certificate Technical Course (CTC) on "Defect free welds: Process control is the key" | Mr. Vijay Agwan<br>M.Tech (IIT Kharagpur), IWE<br><br>Dr. J Krishnan<br>Ph.D. (Welding) IIT, Bombay<br>FNAE | 59 paid delegates attended this course online. |
| 2 | 2nd March 2024 | Annual branch welding seminar<br>Theme: Advancement in Welding Technology & Materials | G L Goswami Memorial Lecture Awarded to Mr Abby Joseph<br><br>Followed by 8 lectures from various experts.<br><br>Concluded with Panel Discussion | Jointly conducted by The Indian Institute Of Welding, Mumbai Branch<br>&<br>FCRIT Student's Chapter at FCRIT College Campus, Navi Mumbai<br><br>130 delegates attended this physical seminar event |

### Other Activities:

#### 1) Managing Committee Meetings:

| Sl. No. | Date | Speaker / Description | Organized by (Student's Chapter, if so) |
|---|---|---|---|
| 1 | 06/01/2024 | 8th MC Meeting<br>(Meeting Number 08/23-24) | Follow-up of the activities & action plans. |
| 2 | 09/02/2024 | 9th MC Meeting<br>(Meeting Number 09/23-24) | Follow-up of the activities & action plans. |
| 3 | 23/03/2024 | 10th MC Meeting<br>(Meeting Number 10/23-24) | Follow-up of the activities & action plans. |

**1) Inaugration of new students' chapter at SNJB College of Engineering, Dhule on 23rd February 2024.**

## MUMBAI RANCH

Dignitaries on the dais releasing the Souvenir copy of
Annual Branch Welding Seminar – IIW Mumbai Branch

Speakers during panel session
at Annual Branch Welding Seminar Event

Delegates during the Annual Branch Welding Seminar

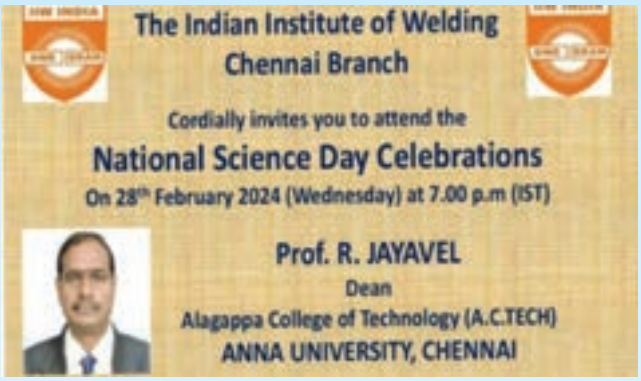
Inaugural Ceremony: Chairman Mr N Kanagasabai, MC member Mr Vishal Mehta along with
College faculty members and members of the newly formed student chapter at SNJB College of Engineering, Dhule

## TIRUCHIRAPPALLI BRANCH

| Sl. No. | Date | Subject | Speaker | Organized by |
|---|---|---|---|---|
| 1 | 09/01/2024 | Logical reasoning in Artificial Intelligence | Dr. S Senthilkumar, M.E., Ph.D., Assistant Professor, Department of Computer Science and Engineering, University College of ngineering, BIT Campus, Tiruchirappalli - 620024. | Organized and Conducted by Mr. R. Selvaraj, Chairman, The IIW-India, Tiruchirappalli Branch in association with The Institution of Engineers (India) Tiruchirappalli Local Centre |
| 2 | 30/01/2024 | Job Safety & Its Hazards Analysis - J S H A and Its Training Awareness | Prof. Dr. I. Manavalan, Former Deputy General Manager, BHEL-Tiruchirappalli - 620014 & Health, Safety & Environment – H S E Consultant Advisor, Tiruchirappalli - 621 703 | Organized and Conducted by Mr. R. Selvaraj, Chairman, The IIW-India, Tiruchirappalli Branch in association with The Institution of Engineers (India) Tiruchirappalli Local Centre |
| 3 | 06/02/2024 | New trends in Sports wear - construction & features | Speaker 1:<br>Er. Ms. Meenu Munjal. M Tech. Ph.D, Asst. Professor,<br>MLV Textile Engineering College, Bhilwara - 311001<br><br>Speaker 2:<br>Er. A Kani Raja, D.T.T., AMIE (TEX Engg.), M.Tech Demonstrator (TT), MLV Textile Engineering College, BHILWARA-311 001 | Organized and Conducted by Mr. R. Selvaraj, Chairman, The IIW-India, Tiruchirappalli Branch in association with The Institution of Engineers (India) Tiruchirappalli Local Centre |
| 4 | 12/03/2024 | Demystifying Blockchain: From Crypto Craze to Real-World Revolution | Dr. T. Vairam, Assistant Professor, Department of Information Technology, M/s PSG College of Technology, Coimbatore- 641004 | Organized and Conducted by Mr. R. Selvaraj, Chairman, The IIW -India, Tiruchirappalli Branch in association with The Institution of Engineers (India) Tiruchirappalli Local Centre |

## CHENNAI BRANCH

### National Science Day Function




The Indian Institute of Welding (IIW-INDIA), Chennai Branch celebrated the **National Science Day (NSD)** on 28th February (Wednesday) through online from 7.00 p.m to 8.30 p.m (IST). Welcome address was delivered by Prof. V. Balasubramanian, Chairman, IIW-INDIA, Chennai Branch. During his welcome address, he briefed about the background of the celebrations of National Science Day and he narrated about the contributions of Sir Chandrasekara Venkata Raman (Sir. C.V. Raman) to the Indian Science and his Nobel Prize Winning inventions. He informed the audience that the Nobel Prize Winning Research Paper was published on 28th February 1928 and later on that research paper was chosen for Nobel Prize and it was awarded to Sir C.V. Raman in 1930 and he also informed that Sir C.V. Raman was the first Indian to win this coveted Prize, having all his studies in India.

Prof. S. Malarvizhi, a Management Committee Member, introduced the Chief Guest, Dr. R. Jayavel, Professor & Dean, Alagappa College of Technology, Anna University, Chennai. She also informed the audience briefly about accomplishment of Prof. R. Jayavel (Former Director of Centre for Nanoscience and Technology; Former Director of Centre for Research and Centre for International Affairs at Anna University, Chennai).

Prof. Jayavel delivered a highly informative Technical Talk on "Two Dimensional Nano Structures for Sustainable Energy Storage Applications". Initially he briefed about Sir C.V. Raman and his contribution to the development of Science in India. Then he briefly explained the basics of Nano Science and Nano Materials and its applications in the present context. He elaborated on various methods of manufacturing Energy storage devices, capacitors and batteries. Then he presented lot of case studies/ research works carried out in his Nanoscience and Technology Centre, Anna University in collaboration with Japanese University on Nano Structures for Energy Storage applications.

The program was attended by nearly 75 participants from all over the country through online. The Management Committee Members, Shri M. Krishnamoorthi, IGCAR, Kalpakkam, Shri A.V. Raghupathy, CVRDE, Avadi, Shri Harihara Swaminathan, ICF, Chennai, Dr. P. Sivaraj, CEMAJOR, Annamalai University, Prof. K. Shanmugam, Annamalai University, Dr. S.T. Selvamani, Professor, Chennai Institute of Technology, Dr. Ruskin Bruce, Professor, St. Joseph's College of Engineering, Chennai, and IIW Students Chapter Members from various engineering colleges attended the program. Many of the participants expressed their feedbacks in Chat box as an Excellent Talk, Wonderful Talk, and highly informative Talk.

Shri. M. Krishnamoorthi, Scientific Officer, IGCAR, Kalpakkam and Vice Chariman of IIW-INDIA, Chennai Branch compiled and briefed about the Talk by Prof. Jayavel and proposed Vote of Thanks. Finally, the function culminated with National Anthem.

# Report of 6th INTERNATIONAL CONGRESS (IC-2024) along with concurrent events Young Professionals' International Conference (YPIC-2024) and WELDEXPO 2024

# INTERNATIONAL CONGRESS (IC-2024)

## Day-1: 22nd January 2024

The **6th International Congress IC 2024** was held during **22nd to 24th of January 2024**, at the **Bangalore International Exhibition Centre (BIEC).**

On 22nd of January 2024, the beginning of IC-2024 was done with the National Anthem. After the welcome address by Mr. T. Ravi Kumar, Chairman of the IC-2024 Preparatory Committee, lighting of the lamp by the dignitaries with Invocation was done as per the tradition. After the presidential address by Mr. Deepak V. Acharya, President, The Indian Institute of Welding (IIW-India), Mr. Robert E. Shaw Jr., Vice President, International Institute of Welding (IIW), formally inaugurated the event.

Dr. P. Veeramuthuvel, Project Director of Chandrayaan-3, ISRO, was the Chief Guest of the event and with an inspiring speech he stressed on the intricacies on the various stages of development and planning of Chandrayaan-3 and the highest level of achievement by India. The audience was mesmerized having him with them. Mr. Nilesh Shah, Vice President of Jindal Steel & Power Limited, addressed the gathering as the Guest of Honour. Special Guest Mr. Anil V. Parab, Whole Time Director & Sr. Executive Vice President, L&T Limited., released the Souvenir of IC-2024 along with the special issue of Indian Welding Journal. Dr. Luca Costa, CEO, IIW, and Mr. R. Srinivasan, Chairman, International Advisory Committee, IC-2024, delivered their speech informing about the importance of the event. Finally, Mr. R. Shiva Kumar, Convenor of the IC-2024 Preparatory Committee, proposed the Vote of thanks to end the inaugural session.

IIW-India award ceremony was also conducted during the inaugural session, which was administered by Mr. Rituraj Bose, Hony. Secretary General, IIW-India. On this occasion, IIW-India conferred the 'IIW-India Excellence Award for Services to the Institute' to Mr. Subhendu Chaudhuri, Director, ANB-India and to Mr. R. Srinivasan, Past President, IIW-India & Vice President, International Institute of Welding, for excellence in sharing and dissemination of knowledge in welding science and technology and their active associations with the Institute. Also, 'IIW-India Excellence Award for International Relations' conferred to Dr. Luca Costa, for excellence in sharing and dissemination of knowledge in welding science and technology globally, through active technological statesmanship. Further, IIW-India was honoured to present its 'Lifetime Achievement Award 2023' to Mr. Ranajoy Banerjee, Hony. Secretary (1987-1989), IIW-India, CEO of ANB-India & Scheme Manager of ANBCC-India, in recognition of his selfless devotion and dedicated contribution to the welding industry as well as to the institute and having the expertise in the field of welding science and technology for more than 50 years. Minati Bhattacharjee Memorial award for the Best Performing Branch was bagged by the Baroda Branch of the Institute.

Many awards were handed over thereafter to the presenter of best papers in different fields during the previous National Welding Seminar and National Welding Meet of the institute, along with Best PhD and M.Tech thesis awards. Apart from these, awards for different National Skill Competitions and Best Students' Chapter Awards also were handed over to the winners and Runners-up. The award ceremony showed the support of the institute to the achievers and to bring the young professionals and others towards the welding fraternity.

After the Hi-Tea, three Award lectures were delivered as follows, which was Chaired by Mr. Deepak V. Acharya, President, IIW-India:

a) Jaegar Lecture of IIW was delivered by Mr. Anil V. Parab, Whole time Director & Senior Executive Vice President, Larsen & Toubro Limited., on the topic 'A perspective on Sustainable and Green Welding'.

b) Keith Hartley Memorial Lecture of IIW-India was delivered by Prof. Santanu Das of Kalyani Govt. Engineering College, on 'Exploring Appropriate TIG Welding Condition for Joining Austenitic Stainless Steel Flats towards its Application in Advanced Ultra Super Critical Boiler'.

c) Prof. Placid Rodriguez Memorial Lecture was delivered by Prof. Vishvesh Badheka of Pandit Deendayal Energy University, on 'Overview of Recent Advances in Fusion and Solid-State Welding'.

After the lunch, one Plenary Session and one Panel Discussion has been organized and the Speakers were invited from

various Industries, Institutes and the Government Bodies. Also, the felicitations were given to the sponsors and supporters of the event.

### Plenary Session – 1 : National Welding Capability

This session was Chaired by Mr. R. Srinivasan, Chairman of International Advisory Committee, IC-2024. The speakers and the discussions were as follows:

- Mr. Deepak V. Acharya, CEO, Inox India Ltd., delivered the Keynote Speech on 'Assisting India in Building-up its National Welding Capability (NWC) and Progressing the UN Sustainable Development Goals (SDGs)', which is co-authored by Mr. Chris Smallbone, Past President, IIW and Chair, IIW TG-SDG.
- Mr. Rituraj Bose, Hony. Secretary General, IIW-India, delivered a presentation on 'Role of IIW-India towards Nation Building', featuring different activities of IIW-India and its support to the welding fraternity.
- Dr. K. Socrates, Joint Director & Head Development, MSME, Karnataka Region addressed the gathering informing about the 'Skill Development Initiatives and various Schemes by the Indian Government'.
- Dr. Shaju K. Albert, Chairman, MTD-11, Bureau of Indian Standards, delivered presentation on Newly released Standard on 'Qualification and Certification of Welding Inspection Personnel'.
- Dr. Luca Costa, CEO, IIW, presented the 'Role of International Institute of Welding supporting the Member Societies and for the Countries for their New Welding Capabilities'.
- Finally, the summing up of the session was done by Mr. R. Srinivasan, along with a lively discussion with the interaction of audience.

### Panel Discussion on 'Welding - Road Ahead'

This Panel discussion on 'Welding – Road Ahead' was moderated by Mr. V. V. Kamath, MD, Fronius India Pvt. Ltd. The Panelists were:

- Dr. Murugaiyan A, Associate Professor, IIT Madras
- Mr. Mahendra Patil, National Head, Robot Sales, Fanuc India Ltd.
- Mr. Ravi Kumar Palli, Marketing Director, ESAB Asia Pacific
- Mr. Yogesh Kumar, COO, Difacto Robotics & Automation

Day-1 was attended by 390 delegates, which included Guests, Authors and Awardees from various Industries, Industrial Associations, Academic Institutions, Research Organizations, Public Sector units, etc.

In the evening, a cultural programme was staged on different dance forms of India, and, also with the engagement of the audience for different ice-breaking activities. The eventful day finally ended with a Gala dinner.

## Day-2 : 23rd January 2024

### Keynote Speech

Day-2 started with the Keynote Speech by Mr. Robert E. Shaw Jr., on 'Managing to Achieve Sustainable and Green Welding', which showed the way forward to save our environment.

### Plenary Session – 2 : By American Welding Society

After the Keynote Speech, there was Plenary Session 2 by the American Welding Society (AWS), followed by interactions with the audience. The Session was Chaired by Mr. Richard Arn, Vice President, AWS.

Lectures delivered in the session were as follows:

- Mr. Viji Kuruvilla delivered a speech on the topic 'Steel Fabricator's Role on Sustainability'.
- Dr. Murali Tumuluru delivered a speech on the topic 'Advanced Steel Grades and New Joining Technologies for Automobiles of Tomorrow'.
- Mr. Ramesh Shankaran delivered a speech on the 'AWS Educational Resources and Solutions'.

### Parallel Technical Sessions

After completion of the Plenary Session – 2, there were 4 parallel Technical Sessions, which were framed and managed by Mr. Dileep V. Kulkarni, Chairman of the Technical Committee, IC-2024. The different topics of the parallel Sessions were as follows:

- Fabrication, Automation and Productivity
- Performance of Weld Deposits and Joints
- Arc Welding Processes
- Health, Safety and Environment
- Weldability and Filler Metal Development
- Additive Manufacturing
- Resistance Welding, Solid State Welding and Allied Processes

- Simulation, Modelling, AI & ML
- Power Beam Processes

### ANBCC-India Workshop

One particular session of Day-2 was dedicated to the invited audience, those who are interested in Company Certification in accordance with ISO 3834. This Session was Chaired by Mr. Deepak V. Acharya, President, IIW- India. The detail of the Workshop is hereunder:

- Welcome Address by Mr. Deepak V. Acharya, President, IIW-India.
- Introduction to the IIW certification scheme for companies (ISO 3834) and relationship with the product standards used in the main markets (EU & USA) by Dr. Luca Costa, CEO, IIW.
- Services delivered by IIW India for Welding Quality Certification for the Indian fabrication industry by Mr. Ranajoy Banerjee, Scheme Manager, ANBCC-India.
- Feedback by Inox India Ltd. with respect to ISO:3834 certification through ANBCC-India by Mr. Pratik Gandhi.
- Feedback by Plasser (India) Pvt. Ltd. with respect to ISO:3834 certification through ANBCC-India by Mr. Chintan Gohil.
- Open House discussions and clarification on queries by the expert panel.
- Vote of Thanks by Dr. Mahadev Shome, Deputy Scheme Manager, ANBCC-India

Day-2 Ended with the gathering of knowledge and information by the audience for the topic of their interest. Thereafter, the 335th Council Meeting of the Indian Institute of Welding was conducted with the presence of Office Bearers, Council Members, Branch Representatives and Invitees, to call it a day.

## Day-3 : 24th January 2024

### Parallel Technical Sessions

Continuing from Day-2, there were 3 parallel Technical Sessions on Day-3, apart from the Young Professionals' International Conference for the full day. The different topics of the parallel Sessions were as follows:

- Fabrication, Automation and Productivity
- Performance of Weld Deposits and Joints
- Arc Welding Processes
- Weldability and Filler Metal Development
- Resistance Welding, Solid State Welding and Allied Processes
- Repair and Reclamation
- Dissimilar Metal Welding

## YOUNG PROFESSIONALS' INTERNATIONAL CONFERENCE (YPIC)

On the Day-3, Young Professionals' International Conference was organised for the whole day, alongside the parallel Technical Sessions. Dr. Luca Costa, CEO of IIW, chaired the inaugural session of the conference.

Inaugural Keynote Address was delivered by Dr. Kittichai Sojiphan, Chairman of Working Group – Young Professionals, IIW, where he has informed about the opportunities of the Young Professionals to be associated with the International Institute of Welding. Next was the invited talk by Mr. Ernest D. Levert Sr., Past President, AWS and Past Chairman of Working Group – Young Professionals, IIW, who delivered speech on 'Welding of the International Space Station Thermal Control Units - KEEPING COOL IN SPACE'. Other Invited talks were delivered by Dr. Renu N. Gupta, Head, Project Management & Welding Engineering, L&T Limited., Heavy Engineering IC, on 'Opportunities for Young Welding Professionals in Heavy Engineering' and by Prof. Sunil Pandey, LNMIIT Jaipur, on 'Moving on the Highway of Innovative Research in Welding'. Apart from the above, several interesting papers on research work were presented by the Young Professionals within the age of 35 years.

### VALEDICTORY SESSION

At the end of Day-3, a Valedictory Session was conducted before ending the 6th International Congress. Out of 135 abstracts accepted, 122 papers were scheduled for presentation, out of which 103 papers were presented in 23 sessions, which is 76.3% of accepted abstracts. Also, there were 8 invited talks by the eminent speakers. The valedictory session revealed that the quality of the papers were of high standards, and the overall event was a grand success.

During the Valedictory Session, the award for Best Presented Paper was declared in favour of Dr. Manikandan Manoharan, Associate Professor (Senior), VIT – Vellore Campus, for his paper 'A Comparative Evaluation on the Microstructure and Mechanical Properties of MDN 250 Grade Maraging Steel Joined by Gas Metal Arc Welding and Gas Tungsten Arc Welding Techniques'. Other awards will be declared after review of all the technical papers by an expert panel under the Chairmanship of Mr. Dileep V. Kulkarni, Chairman, Technical Committee, IIW-India, and all the awards will be handed over during the next National Welding Seminar of the Institute.

## WELDEXPO 2024

For the first time, WELDEXPO was organised concurrently with IMTEX Forming Exhibition of IMTMA (Indian Machine Tools Manufacturers' Association), in Association with IIW-India, between 19th to 23rd January 2024. This specific welding related exhibition was conducted at the same venue of the International Congress, i.e., at Bangalore International Exhibition Centre. The overall response from the welding related organisations was overwhelming and the Exhibitors were very happy on the footfall of the show. Around 1676 sqm area was occupied by WELDEXPO and total footfall was around 45,000 for overall IMTEX Forming Exhibition.

## CONCLUSION

Every person, those who have attended the International Congress, was very happy because of the well organised event along with the hospitality and returned home with the unforgettable memories. IIW-India will take the responsibility to support the welding fraternity in future too, like the earlier years.

## NOTE FOR THE AUTHORS

There is an opportunity for the authors to publish their papers, presented in IC-2024, in a special issue of peer reviewed journal "Welding International", a Taylor Francis publication. This initiative is being coordinated by Prof. Vishvesh Badheka, Chairman of the Young Professional and Student Activity, IIW-India.

# INTELLIGENT WELDING MANUFACTURING SYMPOSIUM during IIW 2024 on July 7th, 2024 at Rhodes Island, Greece.

Dear IIW community,

In the context of the **77th IIW Annual Assembly and International Conference on Welding and Joining**, a Symposium on Intelligent Welding Manufacturing is organizing, on 7th of July 2024. Intelligent welding systems technologies are shaping the Industry future and advancing the welding and joining processes to new frontiers.

### Join us in a world of Join!

The Symposium topics includes, among others.

- Welding manufacturing processes sensing, monitoring, identification (dynamic model) and control
- Robotization of all welding manufacturing processes
- Human-robot collaborative welding and additive manufacturing
- Application of deep learning, artificial intelligence, computer vision, image/signal process processing to welding manufacturing
- Application of data driven techniques to welding manufacturing
- Future Development

### Presentation Portal (eventsair.com)

The Intelligent Welding Manufacturing Symposium is going to take place, in Rhodes Island, Greece, on Sunday 7th of July 2024, in the Context of the 77th IIW Annual Assembly and International Conference, in Rodes Palace, from 9.00 to 17.00

Registration option only for the Symposium of Intelligent Welding Manufacturing is provided. Please proceed to Registration page, for further information.

If you wish to present, please do not hesitate to access the Presentation Portal (eventsair.com). The Symposium organizers will feed back you in a short time.

We are looking forward to meeting you in Rhodes!

Yours sincerely,

**Rosario Russo**
Administrative & Communication Specialist
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Mobile: +39 3316819665
Headquarters and Office:
Lungobisagno Istria 15A – 16141 Genova – Italy

## International Institute of Welding
## Join to the Future

**Our vision:**
The leading global welding community linking industry, research and education

**Our Mission:**
Advance welding and joining through a worldwide network

# THE INDIAN INSTITUTE OF WELDING

**(A Member Society of The International Institute of Welding)**

**Registered & Head Office**

IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park, 200 Kalikapur Main Road, PO: Mukundapur, Kolkata - 700099, INDIA
Tel: 91 33 2416 0826 / 2416 0942 | Telefax: 91 33 2416 0826 | E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com
CIN : U27310WB1966GAP026807


## AMIIW Examinations : Summer Session: 2023-24 during July 13th 2024 and July 21st 2024

### SCHEDULE

(E = Existing)

| Date/ Day | Forenoon 10:00 A.M. - 1:00 P.M. | Afternoon 2:30 P.M. - 5:30 P.M |
|---|---|---|
| 13.07.2024 (Saturday) | 01: El. Mathematics (AME 01(E))<br>02: Heat & Mass Transfer (AME – 14(E))<br>03: Testing & Quality-Assurance (AME – 19(E))<br>04: Testing & Quality Assurance (AME-201) | 01: Physics (AME -02 (E))<br>02: Welding & Allied Processes I (AME 15(E))<br>03: Welding Applications (AME -21 (E))<br>04: Welding & Allied Processes –I (AME -104)<br>05: Welding Metallurgy of Non Ferrous Alloys, Dissimilar Welding and Cladding (AME-202) |
| 14.07.2024 (Sunday) | 01: General English (AME -04(E))<br>02: Computational Methods & Computer - Programming (AME-18 (E))<br>03: Welding and Allied Processes-II (AME-203) (AME -22 (E)) | 01: Industrial Sociology (AME -06 (E))<br>02: Material Science (AME -09 (E))<br>03: Welding Equipment & Consumables (AME -23 (E))<br>04: Weldment Design & Weld Procedure (C-23(R))<br>05: Material Science (AME 101)<br>06: Weldment Design, Welding Procedure and its Applications (AME- 204) |
| 20.07.2024 (Saturday) | 01: Strength of Materials (AME -07 (E))<br>02: Engineering Drawing (AME -11 (E))<br>03: Strength of Materials (AME -102)<br>04: Occupational Health, Safety and Environmental Issues in Welding and Related Areas (AME-205) | 01: Applied Mechanics (AME -05 (E))<br>02: Welding Metallurgy - I (AME -16 (E))<br>03: Engineering Economics (AME -17 (E))<br>04: Economics of Welding and Fabrication (AME -106) |
| 21.07.2024 (Sunday) | 01: Chemistry (AME -03 (E))<br>02: Engineering Mathematics (AME -12(E))<br>03: Welding Metallurgy – II (AME -20(E))<br>04: Welding Metallurgy of Steels (AME -105) | 01: Electrical Engineering & Electronics (AME -08 (E))<br>02: Production Engineering (AME -10 (E))<br>03: Advanced Welding Technology (AME -24 (E))<br>04: Production Engineering (AME -103)<br>05: Advanced Welding Technology (AME-206) |

**Last date for Receipt of Enrollment Forms : June 21st 2024**

**Rituraj Bose**
Hon. Secretary General

# THE INDIAN INSTITUTE OF WELDING

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Tel: 91 33 2416 0826 / 2416 0942 | Telefax: 91 33 2416 0826 | E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com

CIN : U27310WB1966GAP026807


## Report on AM-IIW Examination

Winter Session 2023-24 of AM-IIW Examinations were conducted by Pen-Paper method under online supervision on January 13-14 2024 and January 20-21 2024 in two halves. Total 6 candidates applied for 27 papers of 12 subjects and 02 new applications were received in AM-IIW new syllabus for this Winter Session. 5 candidates appeared on 20 papers of 10 subjects and successfully completed the examinations. After the completion of written examinations, viva voce examinations were conducted from 01.03.2024 to 04.03.2024. Total 4 candidates appeared on the viva voce examinations.

Results of the Winter Session 2023-24 AM-IIW Examinations were published on 18.03.2024. Total 4 candidates passed in 10 papers of 9 subjects. Out of which 1 candidate failed on 5 papers of 5 subjects for not attending the VIVA Voce Examinations and another one candidate passed in written examination but failed in VIVA Voce Examination. They will get the scope of appearing in viva voce examination second time within one month from the date of publication of results.

**Rituraj Bose**
Hon. Secretary General

## LIST OF ADVERTISERS IN INDIAN WELDING JOURNAL
## Vol. 57, No. 2, April 2024

1. D&H Secheron
2. Electronic Devices
3. ESAB India Ltd.
4. EWAC Alloys Ltd.
5. Fronius India Pvt. Ltd.
6. FSH Welding India Pvt. Ltd.
7. Gee Limited
8. India Welds
9. Kemppi India
10. Mailam India Ltd.
11. SAP Industries
12. Spatter Cure Enterprises
13. Weldwell Speciality

Certificate No: 22/3
ANBCC-IND

# ANBCC - INDIA NEWS

## From January - March-2024

### 1.0 Introduction

1.1 During this quarter (4th quarter) of FY 2023-24 ANBCC division had carried out maximum number of activities and maintained the trend set in 1st quarter of FY 2023-2024.

1.2 During current quarter ANBCC successfully conducted One New Certification audit as per ISO 3834-3, One Stage I audit as per ISO 3834 -2, 5 Nos. of Surveillance Audits as per ISO 3834-2 & ISO 3834-3 combined, 1 No. New Certification Audit as per EN-15085 CL1 and 2 Nos. Surveillance audits as per EN-15085 CL1.

1.3 All the audits as above were carried out on site with one from another auditor off site.

1.4 The audit as per EN:15085 carried out by ANBCC's Indian Auditor independently as per the signed agreement between IIW-India and IISCERT.

### 2.0 Details of activities by IIW-India-ANBCC during the period: January to March - 2024

| Sl. | Audit Type | Nos. | Type of activity and its status |
|---|---|---|---|
| 01 | New Certification (ISO:3834-3) | 1 | The audit was carried out by two auditors one on site and other off site. New Certificate issued. |
| 02 | New Certification - Stage 1 (ISO:3834-2) | 1 | Detailed observation report including GAP Analysis issued. |
| 03 | Surveillance Audit (ISO:3834-2) | 4 | The audits were carried out by one auditor on site. |
| 04 | Surveillance Audit (ISO:3834-3) | 1 | The audits were carried out by one auditor on site. |
| 04 | New Certification (EN-15085CL1) | 1 | The audits was carried out by ANBCC Auditor on site. New Certificate issued by IISCERT. |
| 05 | Surveillance Audit (EN-15085CL1) | 2 | The audits were carried out by ANBCC Auditor on site and as IISCERT's Auditor on site as observer at one site. Validity of respective certificates updated at IISCERT website. |

### 3.0 IAB/IIW related activities:-

3.1 The 77th, IIW- Annual Assembly will take place at Greece in the month of July'24.

As decided Dr. Mahadev Shome, new Scheme Manager and CEO of ANBCC and ANB respectively will be joining the IAB's Group A. Group-B and IIW' Members meetings on ANBCC and ANB behalf.

### 4.0 IIWIPC related activities:-

4.1 As reported in the 2nd quarter report, a new division named as "IIWIPC" has been formed under IIW-India to apply for accreditation as CB from NABCB.

4.2 All quality documents viz. QM (Quality Manual), PM (Procedure Manual) & SD (Scheme Document) have been prepared after review by 4 members of working Group.

4.3 These documents have been circulated among all GC members for obtaining approval by 08-04-24.

4.4 Once the above approval is obtained these documents will be placed to NABCB for approval of the scheme.

### 5.0 Other activities/progress

5.1 **ANBCC Division** of IIW-India participated at Weld Expo from 19th – 23rd January 2024 & also organised a Workshop for existing Client Organizations during IC-2024, Bangalore on 23rd January 2024 between 14:00 and 16:00 hrs. with following programme.

a) Welcome Address- Mr. D.V. Acharya, President, IIW-India.

b) Introduction to the IIW certification scheme for companies (ISO 3834); relationship with the product standards used in the main markets (EU; USA) - **Dr. Luca Costa, CEO, IIW** .

c) Services delivered by IIW India for Welding Quality Certification for the Indian Fabrication Industry - Mr. R. Banerjee, SM-IIW-India-ANBCC

d) Presentations by M/S Plasser & M/S INOX (client organisations) to highlight the effectiveness of ANBCC's services to them. It was then followed by an open house discussion between participating representatives from Client Organizations and ANBCC's officials/assessors on any queries on product certification related matters. It was attended by approx. 30 participants

5.2 Fourth MC Meeting was held on 22nd March 2024.

5.3 Internal Audit was conducted by Mr. M. K. Nandi on 21st February 2024

### 6.0 Specific advantages of IIWs MCS

- Beside ensuring compliance with the requirements of ISO:3834, it also covers the welding related aspects of
  a) Environment as per ISO:14001 and
  b) Health & Safety as per OHSAS
- Under MCS of IIW, the certificate is valid for 5 years. Renewal of Certificate are carried out after 4 years of surveillance audits, while as per other certification schemes by competitors the Renewal of Certificate are carried out after 2 years of surveillance audits as the new certificate's validity is 3 years.
- As per MCS, it is a mandatory requirement to assess the competence of WCs, which is also a requirements per new version of ISO:14731:2019.

# ANB – INDIA NEWS

**From January to March 2024**

## INTRODUCTION

ADOR WELDING TRAINING DIVISION at Pune part of ADOR WELDING LIMITED was formally certified as an Approved Training Body (ATB) for conducting International Welder course as per IAB Guideline IAB-089 Part I & Part III

The 2024 Winter Meeting of IAB in hybrid mode took place from 9th January 2024 to 11th January 2024, Dr Shaju Albert, Mr Dileep Kulkarni and Mr R Banerjee participated from ANB-India side. They were joined by Dr Mahadev Shome, Mr Subhendu Chaudhuri & Mr Aloke Bose.

The sixth International Congress (IC-2024) along with concurrent Exhibition with media partner WELDFAB TECH was held between 22nd January and 23rd January '2024. Mr. Suman Chakraborty and Mr. Rajdeep Saha were deputed to manage the IIW-India stall.

Mr. Ranajoy Banerjee currently CEO-ANB and Scheme Manager- ANBCC would be retiring with effect from 1st April 2024 and Dr. Mahadev Shome will take charge for the same responsibilities for ANB & ANBCC.

In recognition of Mr. Banerjee's contribution to IIW-India for several decades and establishing the activities of ANB followed by ANBCC, he was honoured by IIW with the Lifetime Achievement Award. Mr Subhendu Chaudhuri - Director ANB was also conferred the IIW-India Excellence Award in recognition of his immense contribution towards ANB's growth and performance.

## ANB ACTIVITIES

During this quarter the following activities took place:

### IWCP: IWE/ IWT STANDARD ROUTE

The 14th Standard Route batch of IWE/IWT has already commenced from November 2023 at IIW-ANB ATB Cornerstone Academy, Chennai with 49 fresh candidates in hybrid mode and the programme is continuing as per the lesson plan.

For latest details please contact

Mr. Joshua Sajja
Mob: +91 98408 55583.
E Mail: cornerstonewelding@gmail.com
Address:
Plot No. 98, 1st Street. Viduthalai Nagar
S. Kolathur, Thoraipakkam-Pallavaram 200' Road
Kovilambakkam PO
Chennai – 600 117

### IWCP: IWE/IWT ALTERNATIVE ROUTE

The 17th Alternative Route examination was conducted from 5th Feb'24 to 09th Feb'24 along with a few Standard Route candidates (4 nos.) simultaneously at three locations viz. Baroda, Kolkata & Chennai (Cornerstone Academy). A total of 26 candidates (11 fresh & 11 re-appearing and 04 STD RT re-appearing candidates) have attended the theory written examination followed by oral interview under direct ANB invigilation. The result are under evaluation.

### IWCP: IWE, IWT, IWS & IWP TRANSITION ARRANGEMENT

The 97th Refresher Course under Transition Arrangement was conducted successfully during Nov-Dec 2023. A total of 33 candidates have attended out of which 15 candidates were awarded Diploma at different levels as given in ANNEXURE-1.

### INTERNATIONAL WELDER (IW) STANDARD ROUTE

#### ATB Don Bosco, Cochin

Based on the declared results of 29th IW examination held during August' 2023, the names of awardees of Comprehensive Diploma in a process covering Fillet, Plate/Butt & Tube/Pipe are furnished in Table-I.

For latest details please contact

Principal - Fr Raju Philip sdb
Mob: +919483360106,
E Mail:unnaramkallel@gmail.com
Other Contact: Preethy James (+91 9446029120)
Address:
Chittoor Road, Vaduthala
Kochi – 682 023

#### ATB ADOR Welding Training Division, Pune:

ADOR had applied to be an ATB in December 2022 and after completion of all prescribed documentation and procedure, the final approval was given to ADOR for conducting IW curriculum with effect from 2nd February 2024. They have already started imparting course with 7 students.

For latest details please contact

Course Coordinator: Mr. Harshal Borole
Mob: +91 9130508311
E Mail: harshalborole@adorians.com
Address:
Survey No. 147/2B +3, Akurdi, Chinchwad
Pune – 411 019

**ANNEXURE – I**

97th Refresher Course – Transition Route
Awardees of IWE/IWT Diploma Certificates

| Sl No. | Name | Diploma |
|---|---|---|
| 1 | Vijay Richard Gomes | IWE |
| 2 | Kamal Kishore | IWE |
| 3 | Rajappa Amaresan | IWT |
| 4 | K. K. Subramanian | IWT |
| 5 | Ramaiya Malayalam | IWE |
| 6 | Jagadeesh Narajji | IWT |
| 7 | Amit Avinash Tiwari | IWE |
| 8 | Kiran Murlidhar Bhalerao | IWE |
| 9 | Sibaram Das | IWE |
| 10 | Tejsinh Subhashchandra Kadam | IWT |
| 11 | Vinod C C | IWT |
| 12 | Vijayakumar Kannan | IWE |
| 13 | Balakrishnan Velan | IWT |
| 14 | B. Kolanchinathan | IWT |
| 15 | Subrata Mukherjee | IWT |

**TABLE - I**

IW Exam (29th) – STD RT – ATB Don Bosco
Awardees of IW Diploma Certificates

| Sl No. | Name | Levels | Process |
|---|---|---|---|
| 01 | Ashil Freddy | M2 M4 M6 | ITW 135 |
| 02 | Aman Jaison | E6<br>M4<br>T2 T4 T6 | ITW 111<br>IPW 135<br>ITW 141 C |
| 03 | Abhijit P R | M2 M4 M6 | ITW 135 C |
| 04 | Bilvin E R | E2 E4 E6<br>M2 M4 M6<br>T2 T4 T6 | ITW 111 C<br>ITW 135 C<br>ITW 141 C |
| 05 | Jozef Thomas | E2 E4 E6<br>M2 M4 M6 | ITW 111 C<br>ITW 135 C |
| 06 | Levin Kennedy | M2 M4 M6<br>T2 T4 T6 | ITW 135 C<br>ITW 141 C |
| 07 | Nitin Peter | E2 E4 E6<br>M2 M4 M6 | ITW 111 C<br>ITW 135 C |
| 08 | Steevo K J | E2 E4 E6<br>M2 M4 M6 | ITW 111 C<br>ITW 135 C |
| 09 | Vineeth V | E6 | ITW 111 |

"C" stands for Comprehensive Diploma in a process.

# List of new members inducted during 1st January to 31st March 2023

| Sl. No. | Name | Branch |
|---|---|---|
| **A.** | **INDUSTRIAL CORPORATE MEMBER :** | |
| 1 | M/s. Endress + Hauser Wetzer (India) Pvt. Ltd. | Mumbai |
| 2 | M/s. Adishankara Institute of Engineering and Technology | Mumbai |
| 3 | M/s. Carborundum Universal Limited - Industrial Ceramics Division | Chennai |
| **B.** | **LIFE MEMBER:** | |
| 1 | Mr. Meet Kamaleshbhai Patel | Baroda |
| 2 | Mr. Samir Mishra | Kolkata |
| 3 | Dr. Surender Kumar Sharma | Vizag |
| 4 | Dr. Shaileshkumar Natvarlal Pandya | Baroda |
| **C.** | **MEMBER:** | |
| 1 | Ms. Mamta Kumari | Bangalore |
| 2 | Mr. Sujay Manjappa Suvarna | Mumbai |
| 3 | Dr. Sushma Venkata Chinta | Hyderabad |
| 4 | Dr. Yarramsetty Nagini | Hyderabad |
| 5 | Dr. Ashutosh Sahu | Hyderabad |
| **D.** | **LIFE ASSOCIATE MEMBER:** | |
| 1 | Mr. Surendra Kumar Lader | Cochin |
| 2 | Mr. Dewesh Kumar Dhankar | Cochin |
| **E.** | **ASSOCIATE MEMBER:** | **NIL** |
| **F.** | **STUDENT:** | |
| 1 | Mr. Ayush Singh | Baroda |
| 2 | Ms. Rasaniya Bhumika Shivkumar | Baroda |
| 3 | Ms. Kadimisetti Vagdevi Venkata Sai Neelima | Baroda |
| 4 | Mr. Parmar Raviraj | Baroda |
| 5 | Mr. Harsh Ketanbhai Katariya | Baroda |
| 6 | Mr. Tirth Niteshbhai Ghelani | Baroda |
| 7 | Mr. Ye Yint Min Maung | Baroda |
| 8 | Mr. Niyitegeka Alexander | Baroda |
| 9 | Md. Ashu Alam | Baroda |
| 10 | Md. Manzar Alam | Baroda |
| 11 | Mr. Naitik Manishnhai Joshi | Baroda |
| 12 | Mr. Aryan Alam | Baroda |
| 13 | Mr. Vishnu Dilipbhai Joshi | Baroda |
| 14 | Mr. Panashe Magodi Bangura | Baroda |
| 15 | Mr. Shrutik Pareshbhai Pipaliya | Baroda |
| 16 | Mr. Kaushal Bhupatibhai Chavda | Baroda |
| 17 | Mr. Bhavi Shaileshbhai Jivani | Baroda |
| 18 | Mr. Suraj Dinesh Gupta | Baroda |
| 19 | Mr. Absar Aslam Pithadia | Baroda |
| 20 | Mr. Aman Kumar Singh | Baroda |
| 21 | Mr. Utsav Rajnibhai Dangi | Baroda |
| 22 | Mr. Mihirkumar Rajendrabhai Sathwara | Baroda |
| 23 | Mr. Bhavya Haridasbhai Sadrani | Baroda |
| 24 | Mr. Rahul | Baroda |
| 25 | Mr. Ujjwal Kaushlendra Sharma | Baroda |
| 26 | Mr. Anand Raj | Baroda |
| 27 | Mr. Adarsh Sanjeetbhai Giri | Baroda |
| 28 | Mr. Aditya Narayan Singh | Baroda |
| 29 | Mr. Sachin Kumar | Baroda |
| 30 | Mr. Jay Manishbhai Khunt | Baroda |
| 31 | Mr. Avinash Pal | Baroda |
| 32 | Mr. Abhijith B | Cochin |
| 33 | Mr. Adhi | Cochin |
| 34 | Mr. Gamit Prerack Hirenbhai | Cochin |
| 35 | Mr. Godwin Mathew | Cochin |
| 36 | Mr. Joyal Raju | Cochin |
| 37 | Ms. Kavya Chandra | Cochin |
| 38 | Mr. Kevin Philip Jacob | Cochin |
| 39 | Ms. Liya Elizabeth V Koshy | Cochin |
| 40 | Mr. Nirmal Shaji | Cochin |
| 41 | Mr. Paulson K Jose | Cochin |
| 42 | Ms. Shine M Rachel | Cochin |
| 43 | Mr. Tilu K Thomas | Cochin |
| 44 | Mr. B N Lohith | Cochin |
| 45 | Mr. Gobinath K | Cochin |

| Sl. No. | Name | Branch |
|---|---|---|
| 46 | Mr. Gowtham P | Cochin |
| 47 | Mr. Kiran B U | Cochin |
| 48 | Mr. K S Sandesh | Cochin |
| 49 | Ms. Srushti Rajesh Katkar | Mumbai |
| 50 | Mr. Ujwal Prashant Dalal | Mumbai |
| 51 | Mr. Arin Ashish Thale | Mumbai |
| 52 | Ms. Tanvi Gajanan Samant | Mumbai |
| 53 | Mr. Prayag Santosh Sutar | Mumbai |
| 54 | Mr. Vinit Prakash Mhatre | Mumbai |
| 55 | Mr. Siddhesh Atul Shelar | Mumbai |
| 56 | Mr. Tanishk Khandelwal | Baroda |
| **G.** | **TRANSFER of Members:** | **NIL** |

## Summary

| Sl. No. | Category | No. |
|---|---|---|
| 1 | Industrial Corporate Member | 03 |
| 2 | Life Member | 04 |
| 3 | Member | 05 |
| 4 | Life Associate Member | 02 |
| 5 | Associate Member | 00 |
| 6 | Student | 56 |
| | **TOTAL NEW MEMBERS** | **70** |
| | **Transfer of Members** | **00** |

## ATTENTION MEMBERS & NEW APPLICANTS

The membership can be now obtained online through **iiwindia.com**

You are requested to use the following bank account details for deposit of remittances / fees for Membership & AMIIW Examination Services.

| | | |
|---|---|---|
| Bank Account Name | : | **THE INDIAN INSTITUTE OF WELDING** |
| Bank Name | : | **STATE BANK OF INDIA** |
| Type of Bank A/c. | : | Current Account |
| Bank Branch Name | : | Kalikapur, Kolkata |
| Bank Account Number | : | 35603219305 |
| IFS Code | : | SBIN0003907 |

All are requested to forward us the scan copy / screen shot of the transaction details to enable us to keep track of our records accordingly.

# Report on Skill Development Activities

## Assessment under NWTCS:

During the period 1st January 2024 to 31st March 2024 total 01 batch comprising of 30 candidates under MMAW-F were assessed at Rudraksh Institute of Advance Technical Training, Jaipur, Rajasthan. All the 30 candidates were successfully completed their examination and NWTCS certificates were issued. Beside this another 01 batch consisting 15 candidates received for assessment from INOXCVA ITMBU Welding Centre, Vadodara, Gujarat. Assessment of this batch will conducted in April 2024.

# Assessment under Welder Certification:

During the period 1st January 2024 to 31st March 2024 total 01 batch comprising of 10 candidates under Up-skilling Programme for the welders (SMAW & GMAW processes) were assessed at Crescent Foundry Company Pvt. Ltd., Bagnan, Howrah, West Bengal from 14.03.2024 to 19.03.2024. All the 10 candidates were successfully completed their assessment Processes and Certificates of Participation were issued.

**Appointment of new Assessor for assessment of IIW-India's Skill Development activity**

**Applications are invited from suitable candidates on Pan India basis for carrying out assessments under IIW-India's Skill Development Programmes**

## ELIGIBILITY CRITERIA

- **Education Qualification:**
  **Essential:** B.E. / B.Tech / Diploma / ITI
  Minimum experience in welding field:
  a) 5-years for B.E. / B.Tech qualified
  b) 10-years for Diploma qualified
  c) 15-years for ITI and others
- **Professional Experience:**
  - ⋆ Should have wide theoretical and practical knowledge of different welding processes and basic aspect of welding technology
  - ⋆ Should be familiar with practical operation of the following welding processes viz.
    Basic gas welding, Arc welding, TIG welding, MIG MAG/CO2 welding, Pipe welding (TIG+ARC), Gas cutting and Plasma Cutting.
- **Physical attitudes:** Should be physically fit to carry out welders testing activities in a shop for prolonged period of 8 to 10 hours. No optical disabilities like colour blindness or night blindness.

***Applications on plain paper may be sent to :***

**The Indian Institute of Welding**
**Department of Skill Development**
IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park, 200, Kalikapur Main Road,
Kolkata – 700099, INDIA | Email: sdp@iiwindia.com / iiw@iiwindia.com

# THE INDIAN INSTITUTE OF WELDING

(A Member Society of the International Institute of Welding)

**Registered & Head Office**
**IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park,**
**200 Kalikapur Main Road, PO: Mukundapur, Kolkata - 700099, INDIA**
**Tel: 91 33 2416 0826 / 2416 0942 | Telefax: 91 33 2416 0826**
**E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com**
**CIN: U27310WB1966GAP026807 | GSTIN: 19AAATT5926E1ZC**


## OPPORTUNITY FOR BECOMING A CERTIFIED WELDING PROFESSIONAL!!

Dear Professionals,

It is my privilege to inform you all that, in accordance with the resolution taken during the 328th Council Meeting dated 30th July 2022, newly formed **IIW-India Certification (IIWIC) Division** has started its activities for the benefit of Indian fabrication industries. Apart from different certification courses conducted in different IIW-India Branches as per industry requirements, following certifications are offered by the Division:

| Sl. No. | Title of the scheme | Category | Remarks |
|---|---|---|---|
| 1 | Certified Welder (CW) | NWTCS | Various specialisation offered as described in the scheme documents |
| 2 | Certified Welding Trainer (CWT) | TOT | Training of Welding Instructors in line with Industry requirements |
| 3 | Certified Welding Inspector (CWI) | NWICS | Basic, Standard & Advanced levels; also conforms to IS 18224:2023 |
| 4 | Welder Certification | WC | Certification of Welders as per IS, ISO, ASME, AWS, etc. |

We also support industries through customised Awareness Programmes, Skill Gap Analysis in the field of welding, and qualification of welding procedures.

You are requested to contact certification@iiwindia.com with a copy to iiw@iiwindia.com for further details.

With best regards,

**Rituraj Bose**
**Hony. Secretary General**

Date: January 2, 2023

# THE INDIAN INSTITUTE OF WELDING

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**200 Kalikapur Main Road, PO: Mukundapur, Kolkata - 700099, INDIA**
**Tel: 91 33 2416 0826 / 2416 0942 | Telefax: 91 33 2416 0826**
**E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com**
**CIN: U27310WB1966GAP026807 | GSTIN: 19AAATT5926E1ZC**


## GOLDEN OPPORTUNITY FOR INDIAN WELDING PROFESSIONALS!!

Dear Professionals,

It is my proud privilege to inform you all that The Indian Institute of Welding (IIW-India) has partnered with American Welding Society (AWS) to offer their online courses in subsidised and very lucrative rate for Indian Welding Professionals. Do not miss this golden opportunity!

I am sure that the same will be very much helpful for the interested professionals. At present, we are offering seven AWS courses, for which the fees are stated hereunder:

| Sl. No. | Online Courses | Hour | AWS Member Pricing in USD | Non-Member Pricing in USD | Price offered by IIW-India in INR (including GST) |
|---|---|---|---|---|---|
| 1 | WELDING FUNDAMENTALS I (Basic Concepts +Common Welding and Cutting Processes) | 14 | 383 | 511 | 12500 |
| 2 | SAFETY IN WELDING | 3 | 83 | 111 | 7500 |
| 3 | THE SCIENCE OF NONDESTRUCTIVE TESTING | 6 | 194 | 259 | 10500 |
| 4 | ECONOMICS OF WELDING | 18 | 489 | 652 | 12500 |
| 5 | WPS/PQR EXPLAINED | 4 | 131 | 175 | 8500 |
| 6 | LEAN MANAGEMENT FOR WELDING PRODUCTIVITY | 4 | 280 | 373 | 12500 |
| 7 | CAREER READINESS | 8 | 131 | 175 | 5500 |

- Please write to certification@iiwindia.com for enrolment and availing the opportunity.
- Visit https://www.awslearning.org/iiw-india for further details about the courses offered.

Best Regards,

For The Indian Institute of Welding

**(RITURAJ BOSE)**
**Hony. Secretary General**

Date: May 2, 2023

# THE INDIAN INSTITUTE OF WELDING

(A Member Society of the International Institute of Welding)

**Registered & Head Office**
**IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park,**
**200 Kalikapur Main Road, PO: Mukundapur, Kolkata - 700099, INDIA**
**Tel: 91 33 2416 0826 / 98301 23968 | Telefax: 91 33 2416 0826**
**E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com**
**CIN: U27310WB1966GAP026807 | GSTIN: 19AAATT5926E1ZC**


## Register Online for Membership

Dear Professionals,

**Avail the golden opportunity to be a part of the largest welding fraternity in India.** It is now easier to be a member of The Indian Institute of Welding (IIW-India) Online, apart from the existing offline procedure. Professionals are requested to **click the link** https://iiwindia.com/member/ or visit https://iiwindia.com to become a member and to be a part of the family. The criteria as per the membership category are as follows:

| | |
|---|---|
| **MEMBER** | Members being individual,<br>having Engineering Degree / Diploma or its equivalent, or having passed AM-IIW Examination, or Post Graduate Degree / Diploma in Applied Science / Technology, or an Associate Member of the Institute having experiences in the field of welding or its allied subjects with such qualification as the Council may approve; and also having experiences in the field of welding or its allied subjects for a period of minimum 5 years or as decided by the Council. |
| **ASSOCIATE MEMBER** | Associate Members being individual,<br>i) having Engineering Degree / Diploma or its equivalent, or having passed AM-IIW Examination, or Post Graduate Degree / Diploma in Applied Science / Technology, or possessing educational qualification approved by the Council and interested in welding science and technology; Or,<br>ii) having interest in the field of welding and allied processes or craftsmen skilled in the art of welding. |
| **STUDENT MEMBER** | Students being individual,<br>not having reached the age of 25 years, studying Engineering Degree / Diploma / Post Graduation course in an Educational Institution and approved by the Council. |

**Entrance fee and Membership Subscription to be paid as follows:**

| Class | Entrance Fee (Rs.) | ANNUAL MEMBERSHIP | | LIFE MEMBERSHIP | |
|---|---|---|---|---|---|
| | | Annual Subscription (Rs.) | Total Amount Payable (Rs.) | Life Membership Subscription (Rs.) | Total Amount Payable (Rs.) |
| **By every Member** | **1,250.00** | **1,250.00** | **2,500.00*** | **15,000.00** | **16,250.00*** |
| **By every Associate Member** | **750.00** | **750.00** | **1,500.00*** | **9,000.00** | **9,750.00*** |
| **By every Student** | **Nil** | **500.00** | **500.00*** | **---** | **1,000.00*/1,500.00# (*for 3-years at a time) (#for 4-years at a time)** |

*** GST @18% to be paid extra along with the payable amount. (GSTIN of IIW-India: 19AAATT5926E1ZC)**

**Note:**

1. Individuals can opt for Online or Offline process for application as a member of the Institute as per their choice. The link for Online Membership is mentioned above. For Offline Membership, please fill up the application form and forward through email or by post.

2. Remittance against membership application should be in the form of Cash / Demand Draft / Cheque, and will be in favour of **"The Indian Institute of Welding"** payable at Kolkata, **OR** can transfer as per the details given below:

   **Account Name: The Indian Institute of Welding**
   **Current Account No.: 35603219305**
   **Bank: State Bank of India**
   **Branch: Kalikapur (Branch Code: 003907)**
   **RTGS/NEFT/IFSC CODE: SBIN0003907**

WELDING - FOR NATION BUILDING

# THE INDIAN INSTITUTE OF WELDING

(A Member Society of the International Institute of Welding)

**Registered & Head Office**
**IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park,**
**200 Kalikapur Main Road, PO: Mukundapur, Kolkata - 700099, INDIA**
**Tel: 91 33 2416 0826 / 98301 23968 | Telefax: 91 33 2416 0826**
**E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com**
**CIN: U27310WB1966GAP026807 | GSTIN: 19AAATT5926E1ZC**

**Attach 3 Stamp Size Photographs**

## APPLICATION FOR MEMBERSHIP

**1. TO THE COUNCIL of The Indian Institute of Welding:**

I desire to be admitted / transferred as Member ☐ / Associate Member ☐ / Student ☐ of The Indian Institute of Welding. I will be governed by the Memorandum and Articles of Association of the Institute and by its By-Laws as may be in force from time to time. I certify that the statements made by me in this application are true. I enclose remittance of INR. _____ being the Entrance Fee and the Life / First Annual Subscription, on the understanding that it will be returned in the event of my non-election.

**Personal Details:**

**Mr./Ms./Dr.** **Last Name** **Middle Name** **First Name**

_____ _____

**Permanent Address with Pin Code (Mandatory)**

_____

_____

Email: _____ Contact No.: _____

**Name of the Organization with Designation, if any (Optional)**

_____

_____

Email: _____ Contact No.: _____

GSTIN of the Organisation (if sponsored by the Organisation): _____

Date of Birth (dd /mm/yyyy): _____ Nationality: _____

Mailing Address (Tick One): ☐ Permanent ☐ Company

2. Membership of Other Professional Bodies (if any): _____

3. Present Category of IIW-India Membership with No. (If Any): _____ Date of Election _____

4. Academic Qualifications:

| | Last Exam Passed | Name of the Institution / Examination Authority | Year of Passing | Verified & Certified by proposer & seconder |
|---|---|---|---|---|
| a) General Education | | | | |
| b) Technical Education | | | | |
| c) Professional Qualification (if any) | | | | |

Photocopies of all Testimonials and Credentials to be enclosed. Please attach Separate Sheet as required.

**Declaration:** I, _____ (applicant's name), declare that all the information submitted by me in the application form is correct, true and valid. I will present the supporting documents as and when required.

**Date:** _____ **Signature of the applicant:** _____

---

**The application is Approved** ☐ **Not Approved** ☐

_____

**Chairman, General Purposes Committee**
**The Indian Institute of Welding**

# THE INDIAN INSTITUTE OF WELDING

(A Member Society of the International Institute of Welding)
Registered & Head Office
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E-mail: iiw@iiwindia.com | Website: http://www.iiwindia.com
CIN: U27310WB1966GAP026807 | GSTIN: 19AAATT5926E1ZC

## APPLICATION FOR INDUSTRIAL CORPORATE MEMBERSHIP

Name of the Organisation: _____

Address: _____

Tel: _____ Fax: _____

Email: _____ GSTIN: _____

Nature of Business: _____

TO THE COUNCIL of The Indian Institute of Welding:

We, the undersigned _____ hereby apply for admission as an INDUSTRIAL CORPORATE MEMBER (CLASS- ) of the Institute. If elected, we will be governed by the Memorandum and Articles of Association of the Institute and by its By-Laws as may be in force from time to time.

If elected, we nominate _____ of _____ To exercise voting power on our behalf and wish publications of the Institute addressed to. We enclose remittance of Rs._____ Being the Entrance Fee and the subscriptions on the understanding that it will be refunded in the event of our non-election. We certify that the statement made by us in this application are true.

For and on behalf of

Date: _____ Signature: _____

Recommendation by General Purposes Committee: _____

Chairman

Dated: _____ General Purposes Committee

FOROFFICIALUSEONLY

Membership No. _____

Elected as Industrial Corporate Member, Class _____ category, During _____ Council Meeting held at _____ on _____

Receipt No. _____ Date _____ Amount Rs. _____, Certificate of Membership issued on _____.

Chairman, General Purposes Committee

By-laws: 7 & 9

| Categories | Description | For 1-year Annual Subscription | | | For 7-years Compounding Subscription | | |
|---|---|---|---|---|---|---|---|
| | | Entrance Fee (Rs.) | Annual Subscription (Rs.) | Total Amount Payable (Rs.) | Entrance Fee (Rs.) | Amount Payable for Compound Subscription (7-years one-time payment for enjoying benefit of 10-years) | Total Amount Payable (Rs.) |
| Class-I | This shall include companies or firms engaged in the methods and means for welding and its allied processes, fabricators, manufacturers of consumables and equipment etc. and the firm shall have invested capital in fixed assets exceeding Rupees Ten Crore. | 6,000.00 | 6,000.00 | 12,000.00* | 6,000.00 | 42,000.00 | 48,000.00* |
| Class-II | This shall include companies or firms as in Class-I but with invested Capital over Rupees One Crore but not exceeding Rupees Ten Crore; also trade associations or technical societies or government bodies interested in Welding or its allied science / processes. | 5,000.00 | 5,000.00 | 10,000.00* | 5,000.00 | 35,000.00 | 40,000.00* |
| Class-III | This shall include companies or firms having invested capital not exceeding Rupees One Crore; also, Educational Institutions and recognized Technical and Research Institutions. | 4,000.00 | 4,000.00 | 8,000.00* | 4,000.00 | 28,000.00 | 32,000.00* |

* GST @ 18% to be paid extra along with the payable amount. (GSTIN of IIW-India: 19AAATT5926E1ZC)

N.B.: 1. Remittance against membership application should be in the form of Cash, Demand Draft, or at par Cheque or Online Transfer as follows:
**Account Name: The Indian Institute of Welding / Current Account No.: 35603219305 / Bank Name: State Bank of India, Kalikapur Branch / RTGS/NEFT/IFSC CODE: SBIN0003907**

2. Please ensure that application form is completed in all respects.

# INTRODUCTION AND AUTHOR GUIDELINE
# INDIAN WELDING JOURNAL
## (ISSN 0046-9092)

### INTRODUCTION

Indian Welding Journal (IWJ) (ISSN 0046-9092) is the official journal of the Indian Institute of Welding (IIW-India) being published quarterly since 1968. **Volume 50 was published in 2017**. Articles published in it are indexed by **Indian Citation Index**, **EBSCO, USA, i-Scholar,** and **j-Gate**. This journal is recently included in the list of approved journals of the University Grant Commission (UGC). This journal includes selected technical articles published in Welding Journal of American Welding Society. Articles are invited in the broad areas of **welding and cutting** for publication in the IWJ as per the following categories;

a) Original papers
b) Conference papers (For journal special issues, etc.)
c) Critical assessments / Reviews
d) Case studies / Application areas

### TITLE PAGE

The title page should include:

The name(s) of the author(s)
A concise and informative title
The affiliation(s) and address(es) of the authors
The e-mail address, telephone and fax numbers of the corresponding author

### ABSTRACT

An abstract should be of 150 to 250 words and it should not contain any undefined abbreviations or unspecified references.

### KEYWORDS

Four to six keywords should be included.

### TEXT

#### Text Formatting

Manuscripts should be submitted in editable Word files as well as in PDF version.

#### Margins and Spacing

The top, bottom, left, and right margins should be kept one inch each. The text of the paper should be single-spaced and fully justified in 11-point Arial font in single column format. Leave one line space between paragraphs, but do not indent the first line of a new paragraph. Page numbers should be centered at the bottom. Insert a line space after the final paragraph in a section.

First level heading should be consequently numbered like 1., 2., etc., left justified, all caps and bold. Insert one line space before and after a first level heading.

Second level heading should be numbered consequently like 1.1., 1.2., 2.1., 2.2., etc., left justified, with running letter and bold, with one line space above it.

The heading of Abstract, Appendix and References are to be all caps, 11-point, bold, and centered, with two line spaces above, and one below.

#### Figures and Tables

Figures and tables should appear close to their first citation inside the text. Each table or figure should be centered. Each table and each figure should have centered titles that should be self explanatory. Table titles should go above the table and figure captions below the figure. Leave one line space between the title and the table or figure. Figures and tables are to be numbered consequently. Refer these inside the text as Table 1 or Fig. 1, etc. In addition, each figure should be given as separate file(s), naming the file as Fig. 1, Fig. 2, etc. Figures (including photographs, line drawing, etc.) must be clear and reproducible.

### REFERENCES

#### Citation

The list of references should only include works that are cited in the text and that have been published or accepted for publication. Reference citations in the text should be identified by numbers in square brackets. Some examples:

The effect has been widely studied [1-5]. The same results were observed by Reddy et al. [6].

**Example**

[1] Badheka VJ and Albert SK (2009); Improving the weld penetration by application of oxide coating in GTAW of P91 steel, Proc. Nat. Weld. Sem., Kolkata, India, p.18.

[2] Sabiruddin K, Das S and Bhattacharya A (2009); Application of the analytic hierarchy process for optimization of process parameters in GMAW, IWJ, 42(1), pp.38-46.

**APPENDIX AND ACKNOWLEDGMENT**

Appendices, if needed absolutely, should be placed after references section. Uses of appendices are not encouraged, in general. Acknowledgment, appendices, etc., if any, may follow the References section.

**PEER REVIEW PROCESS**

Manuscripts of contributed articles submitted under each category will be double-blind peer reviewed. Author(s) will be communicated with the review results, and if needed, author(s) will be required to incorporate necessary changes in the manuscript for final acceptance.

**PLAGIARISM CHECKING**

All the contributed articles are plagiarism checked by Crossref system powered by ithenticate. A maximum of 10% similarity content will be allowed to a research paper for publishing in the IWJ.

**COPYRIGHT**

Authors will be asked to transfer copyright of the article to the Indian Institute of Welding (IIW-India). To this effect, the corresponding author on behalf of other authors, if any, has to sign and submit a Declaration Form available in IIW-India website.



**INDIAN WELDING JOURNAL ARCHIVE**

Archive of articles published in the Indian Welding Journal since Volume 1 1968 is done and published articles may be found in i-Scholar and j-Gate platform. Readers may please surf the website: http://www.i-scholar.in/ index.php/IWJ.

**ASSIGNING DOI**

DOI (digital object identifier) is being assigned to research articles recently published, or to the forthcoming articles of the IWJ. 10.22486/iwj/2017/v50/i2/146561 is a typical DOI for a published article.

**CONTACT ADDRESS**

The Chief Editor
Indian Welding Journal
The Indian Institute of Welding
IIW-INDIA HOUSE, Plot No. 38, Geetanjali Park,
200 Kalikapur Main Road, Kolkata - 700099, INDIA
Email: iwj.iiw@gmail.com
Website (IIW-India): www.iiwindia.com
Website (IWJ): http://www.i-scholar.in/index.php/IWJ.

# DECLARATION OF THE AUTHOR(S) FOR PUBLICATION OF PAPERS IN THE INDIAN WELDING JOURNAL (ISSN 0046-9092)

This Declaration Form needs be signed by the corresponding author on behalf of other authors, if any. Publication of paper in The Indian Welding Journal (IWJ) will not be taken up without the duly filled-in Declaration Form.

**TITLE OF PAPER:** _____

**Name of author (s)**: _____

I, the corresponding author, on behalf of the other author(s) declare that the submission has not been previously published, nor it is being sent to elsewhere for consideration for publication. I further undertake that the paper manuscript submitted is not copied or plagiarized from any other published work(s).

I hereby transfer the right for publishing the paper in 'Indian Welding Journal' to the Indian Institute of Welding, publisher of the journal in print, electronic and any other form of publication for wide circulation of the articles. The Editor of the Journal and the Indian Institute of Welding are empowered to make editorial changes to the paper suitable for its publication.

I understand that submission of false or incorrect information/ undertaking would invite appropriate penal actions as per existing norms/ rules.

NAME OF THE CORRESPONDING AUTHOR (IN BLOCK LETTERS) : _____

POSTAL ADDRESS FOR CORRESPONDENCE : _____

_____

_____

Pin _____

ORGANISATION INCLUDING DESIGNATION : _____

_____

_____

E-MAIL ID : _____

Signature _____ Date : _____
(Corresponding author)

To
The Chief Editor, Indian Welding Journal
The Indian Institute of Welding
IIW-India House, Plot No. 38, Geetanjali Park
200 Kalikapur Main Road, PO Mukundapur, Kolkata - 700 099, India
E-mail : iwj.iiw@gmail.com | Website : www.iiwindia.com

Any change in address after submission of this Declaration Form, should promptly be intimated to the Institute

# Need of Simulations in Welding

**S M Vaidya**
Advisor - Technical
Godrej and Boyce Mfg. Co. Ltd
Email: smvgodrej@gmail.com

We need two types of simulations in welding,

First to develop/ select WPS that is parameters which will meet Physical test- Tensile, bend, Impact, Micro/ Macro and NDT requirements of the joint. In addition to this we need to also ensure that joint meets the designers' dimensional requirements and does not shrink, distort beyond allowances kept considering feasibility of machining. In some cases such rectification is not possible and we need to select parameters/ sequence or tools/ jigs / fixtures or heating and cooling aids to ensure joint not only will meet Metallurgical properties and NDT requirements but will also be within dimensional requirements. There are few softwares which will simulate material, thickness and joint configuration and may give inputs on WPS parameters but this is like what we developed on our LVD press break by conducting few trials and measuring physical data and then asking LVD to help us to feed in backend of the controller and thus created our own library of aerospace materials and shapes and sizes. Readymade simulation for above is difficult but I understand today with AI and IoT this is being attempted by many Start-ups. Once we begin our journey as we have started on IoT, I am sure we will be able to derive few quick solutions in next couple of months.

Other simulation is used extensively for training and qualification of welders and welding operators. Such simulators are available in the market and one such was made by E&E in the past( I am not sure how many are in use now), these will provide very basic training in improving stability of hand and mainly for stick welding. Now that in aerospace we use mainly TIG where torch just moves and does not come down as there is no consumption of tungsten but with separate hand we feed filler wire, such simulators are very expensive and finally unless welders sees a live arc and fumes and heat, he does not feel the real weld. In MIG also same, wire is continuously fed by machine. So such simulators will suffice we want to have a quick selection of welder or starting a basic training centre but surely not good if we are training for Ti, Al where not only torch but training shield, complex geometries, fixture set up, purge requirements etc cannot be simulated

INDIAN WELDING JOURNAL Volume 57 No. 2, April, 2024

# Welding Consumables: Its Storage, Preservation and Handling Before Using

**S M Vaidya**
Advisor - Technical
Godrej and Boyce Mfg. Co. Ltd
Email: smvgodrej@gmail.com

We use three types of consumables in most of our fabrication. Flux coated , flux cored and Bare- surface improved by copper coating, high finish, pickled and passivated .... We can also classify consumables by cut length or continuous.

Cut length can be straight or random, Continuous can be layer wound or coiled.

Each of this category requires a proper ordering, inspection on receipt and then preservation before we make use of them.

Flux coated mainly welding electrodes of different sizes and lengths but some times we do use flux coated wires for TIG/ Gas Brazing... Most of the time except acidic fluxes like 6013 most of them are hygroscopic in nature needs protection to avoid contact with air. Hermitically sealed, vacuum packed, double sealed with silica gel are some of the measures to protect from contact with air. But another important point here is to avoid physical damage as flux may crack so it shall be properly boxed in plastic or 4ply corrugated hard paper. Holding side and burning side both needs to be protected and rod shall be straight. before using we need to dry them and use in portable ovens till you consume. Normally, issue electrodes those will get consumed in one hour.

Bare electrodes require proper treatment before they are packed. Once again like Flux coated electrodes it is good to pack them in hermetically sealed or vacuum or double pack with silica gel. If in cut length order straight to the most optimum size in plastic cartoon or 4 ply hard paper box. If in spool form, ask for layer wound and with same type of packaging. Size and package weight shall be suited to your machine specifications. Carbon/ Alloy steel wires shall be copper coated, Aluminium shall be with bright finish, Copper, Ni, Ti, Stainless steel shall be pickled and passivated. Bare wire shall be in annealed condition and wound with minimum torque for ease of feeding. Follow ASME/ AWS or other code guidelines on how to inspect it. These wires have to be preserved well if not in use for a long time, specially if, original packing is opened and some quantity has been consumed. While re packing first ensure that spool is in complete dry condition and no dust, oil. Pack it in polythene bag with sufficient silica gel. Before use again inspect surface condition for any oxides, change of colour, corrosion, scratches or any other physical damage.

Flux cored wires are generally layer wound on plastic spools and needs protection from physical damage. Similar precautions shall be taken that of bare wire. Since these wires have flux inside the tube which is aggressive on the metals when molten and hence shall be stored in cool and dry place.

Fluxes also deserve similar care while storage and baking before usage. Any colour change of flux on baking unless and until specified is not acceptable. Fluxes which add alloying elements shall be recirculated with lot of care.

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# Weldability of Materials and Suitability of the Processes and Positions

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Welding Bead on plate or overlay or buttering, fillet or lap and different types of grove joints and position in which you weld are all vastly different and one cannot compare performance in each of these categories with others.

Weldability of materials and suitability of the processes and positions in which each of the alloys can be welded with best possible process is well defined.

I am raising and discussing this issue as I find we do a wrong comparison saying a combination of processes and consumables and gases and other non essential variables were kept sane but I find results different in each toe of joint or positions. Is it not that we should expect a fine variation and instead of having comparison and with it get surprised.

Let us discuss what kind of shrinkage forces surface tension and cooling pattern we will get in bead on plate, fillet and groove. Let us keep other variables off position constant for time being otherwise it will become too complex.

Bead on plate has base material only on the bottom of the weld for 1G or down hand position. Fillet will have it on bottom of the weld and even at right angles bit when we talk of groove it has base material at bottom of the weld except root run where penetration will be floating but has walls of base material on both sides. In other words bead in plate exposed weld to almost 70%, fillet to 50% and groove it is just 25% to atmosphere so cooling patterns and shrinkage stresses it is going to develop are in reverse proportion of 30-50-75%. Surface tension is also equally proportional. If you have dissimilar weld or varying thickness in fillet and groove we have more complexity. Welding parameters may be same or within-+10% but weld properties, finish, level of defects, may vary to great extent. Visual appearance and ease of cleaning beads after it cools down can vary and mislead at occasion to start worrying beyond a point on machine behaviour. In such cases we shall use our engineering judgment and as long as hygiene factors like cleanliness, preheat if required, machine maintains, consumables baking, storage, physical parameters like stick out, angle at which arc is struck, speed and direction… are same or maintained as per WPS, PQR we shall be able to predict behaviour in different types and positions. This knowledge of variations those will come due to overhead welding or vertical up or down welding or all position welding is essential to have by welding engineer. Welding engines shall also be familiar with NDT and metallographic studies and results for a better understanding and rational for weld visual and NDT results. Assuming no defects in the sample variation in results of physical properties would be purely metallurgical these other variations could be due to combination of metallurgical behaviour and physical variations due different types and positions.

To allow certain joints to deform may be a good idea rather than constraining it and developing stresses in the joint & HAZ.

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# High Current-High Speed-High Deposition Welding for Cheaper - Better-Faster Manufacturing.

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Welding is an important process of manufacturing, global competition, global market and global trade forced us to manufacture with highest quality and deliver as per customer demand. Other manufacturing processes like machining, forming, assembly improved a lot in last two decades, so also improvements in welding machines, manipulators and accessories. advancements in materials and material processing technologies helped improving product design and its reliability. Similarly, improvements in welding consumables and NDT techniques are improving quality of the product.

Heat input in welding is necessary for melting of base material and welding consumable. It has to be just appropriate to ensure smooth transition and seamless properties of weld joint. If heat input is less, welding may not have sufficient bond strength and we may land up in defects as lack of penetration, lack of side wall fusion, insufficient reinforcement... whereas on the other side if heat input is more we may have undercuts, voids, unfilled areas... but these are visual defects, we also have metallurgical defects if heat input is more or less.

Manual welding gives choice of heat input to welder and based on his comfort to move around the weld speed and other welding techniques of weave or stringer bead, current is chosen. In Manual welding depending upon the process one uses speed up to 200-300mm/min. If we weave lengthwise speed comes down and depending on position of welding it is further adjusted.

More heat input means wider heat affected zone (HAZ), and distortion or deformation of joint.

Considering above we tend to choose just sufficient heat input. Manual welding or auto welding without today's available accessories will thus ask us to use current and speed combination that can be easily managed by welder or welding operator. However now using seam tracker, AVC, electronic weaving, anti drift rotators, servo controlled manipulators, video cameras, robots... tracking seam at higher speeds is no issue and even if job is of varying profile servo and AVC take care of manning arc length within close tolerances. Electronically controlled welding machines with pure DC and drooping characteristics gives the best output.

All this allows us to us speeds and current as we desire and best for the joint to achieve desired properties. Since current is directly proportional and speed is inversely proportional for calculation of heat input, we shall take advantage and use the best combination of parameters which will give conventional welding techniques to perform like Electron Beam Welding (EBW) or Laser Welding (LW). This will help us in achieving joint properties and also cost and very less distortion. I strongly recommend use of all the accessories and as high current as possible with good tracking and high speeds.

Happy Welding!!!

# CAD-to-Print Strategy for Gas Metal Arc Directed Energy Deposition

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## Abstract

Harnessing between a computer-aided design (CAD) and the actual printing of a part is by far the most arduous task for robotic gas metal arc directed energy deposition (GMA-DED). The generation of a suitable scanning strategy to deposit overlapping tracks and successive layers is currently not supported by an organized single source. Three easy-to-use CAD-to-Print approaches– point-based, feature-based and drawing-based– are presented here utilizing the open-source software for robotic GMA-DED. The point-based approach involves the discretization of the CAD model into a set of target points and suitable for linear paths and regular geometry. The feature-based approach involves the generation of the robot scan path by slicing of the CAD model. It can consider both regular and irregular geometries but suitable for linear paths only. The drawing-based approach involves the robot scan paths drawn along the contours of the CAD model and is flexible for both linear and non-linear scanning paths. Although all the three approaches require user intervention, they have the potential for automation.

**Keywords:** Wire Arc Additive Manufacturing; Gas Metal Arc Directed Energy Deposition (GMA-DED); CAD-to-Print; Path Planning; Offline Robot Programming.

## 1.0 INTRODUCTION

Gas metal arc directed energy deposition (GMA-DED) is the most important technology among various wire arc additive manufacturing (WAAM) processes. GMA-DED involves the fabrication of a part from its computer-aided design (CAD) model and requires the selection of suitable process parameters and an efficient path planning for the welding torch [1-3]. Currently, the welding torch in robotic GMA-DED requires the use of a teach pendant and several iterations to arrive at a suitable scan path, which is tedious and time-consuming [4-6]. As the interest on WAAM is growing in several user industries, there is a substantive demand for an easy-to-use and reproducible methodology for the path planning of the welding torch in robotic GMA-DED [7]. In particular, easy-to-use unified digital tools, which can provide a suitable scanning strategy for the printing of a 3D metallic part directly from its CAD file, are needed but currently scarce [8-9].

The CAD-to-Print strategy broadly encompasses three stages: (a) slicing of part geometry, (b) path planning for the welding torch, and (c) robot code generation [4]. Although dedicated software solutions are available for the first step, similar tools that can provide a seamless solution for all the three required steps are yet unavailable. Substantial efforts are reported in the recent literature to develop CAD-to-Print capability for GMA-DED [8-13]. Ding et al. [8] used machine learning techniques for the development of a suitable scanning strategy of the welding torch. A modular path planning was presented by Michel et al. [10] by segmenting the CAD model into distinct

zones and considering different process conditions such as wire feed rate (WFR) and printing travel speed (PTS) for different zones. A continuous path planning for the welding torch from the bottom to the top layers was employed following the CAD model to reduce the multiple arc start and stop [9,11]. Diourte et al. targeted a path planning strategy to ensure the welding torch to remain perpendicular to the deposition plane [8]. Giordano et al. [11] developed a continuous spiral path planning strategy from substrate to upper layers based on numerically computed temperature field. However, dimensional inconsistency and distortion due to heat accumulation along the part height was a major challenge. Chernovol et al. [12] used a commercial CAD software to construct the scanning strategy for a thin wall deposition, which did not allow much customization. Onstein et al. [13] used a robot specific software to generate the robot scan path based on the point cloud on the CAD model surface. The aforementioned investigations pointed out a growing interest to realise a CAD-to-Print capability for GMA-DED using various commercial and open-source software. An efficient and easy-to-use approach for path planning and robot program generation using open-source software is still in demand.

The finding of the scan path for the welding torch in GMA-DED requires a prior knowledge of the part geometry, track and layer dimensions, and the important process conditions such as WFR and PTS [14-15]. The part geometry is described by a CAD model, which is required to be sliced into segments for multi-directional deposition using a filler wire [16-17]. The generation of such slices requires a prior knowledge of the track and layer profiles that are to be deposited [15]. It is imperative that suitable process conditions to deposit the target track and layer profiles are known. The robot code for the movement of the welding torch must be generated and tested before the actual deposition begins. A robot specific software [18] and an open source CAD software [19] are used in the present work and they are harnessed through a Python script to develop and demonstrate three CAD-to-Print approaches in the present work.

## 2.0 METHODOLOGY

Three CAD-to-Print approaches- (a) point-based, (b) feature-based, and (c) drawing-based- are presented in this work. The steps for each of these approaches, and their respective working principles, advantages and limitations are presented in this section.

The point-based and drawing-based approaches use the vertex and contour information of the CAD model, respectively. In contrast, the edges of a sliced CAD model are used as a feature to generate the path in case of the feature-based approach. The resulting scanning strategy from these three approaches is fed as the teach pendant program (TPP) that finally controls the actual robot. The suitable process conditions such as WFR and PTS are included in the TPP. A prior knowledge of the width (w) and height (h) of the single-track deposit for different combinations of WFR and PTS are required to decide the suitable hatch spacing (δ) and path planning. The hatch spacing (δ) is defined as the centre distance between the two adjacent overlapped tracks [20].

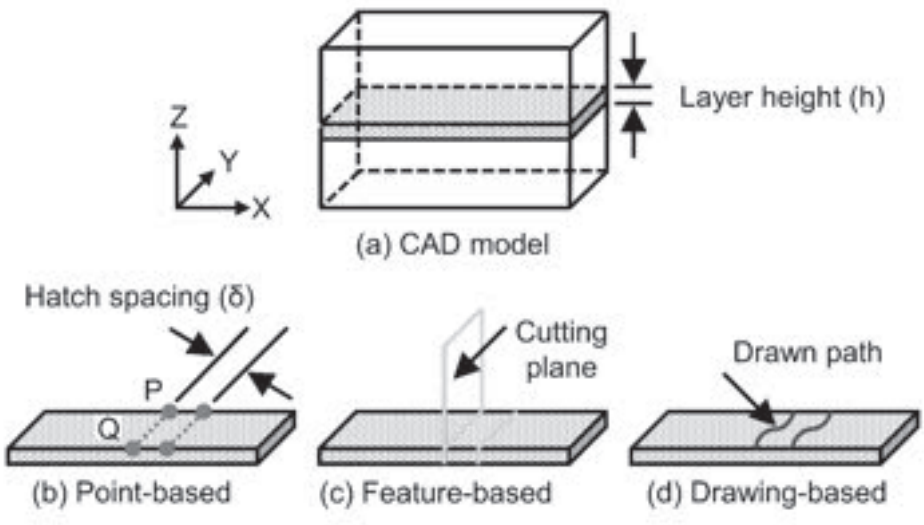


**Fig. 1: (a) Geometric CAD model of target feature, and three different approaches; (b) point-based, (c) feature-based, and (d) drawing-based for the CAD-to-Print.**

**Fig. 1 (a-d)** schematically show a CAD model of a target and three different CAD-to-Print approaches. A strip of thickness equal to the layer height (h) is considered as shown in **Fig. 1(a)**, where the layer height is equal to the height of a single-track. The tool centre point (TCP) is taken at the tip of the filler wire, which is moved from an arbitrary point P to a point Q to trace a designated path. **Fig. 1(b)** shows schematically the point-based approach where the TCP coordinates are obtained by discretising the CAD model using a Python script. In feature-based approach **(Fig. 1c),** the paths are generated through several vertical and horizontal cutting planes using an open source CAD software. For example, the feature in **Fig. 1(c)** is created by vertical slices of a horizontal layer. In the case of a drawing-based approach shown in **Fig. 1(d)**, the appropriate paths are drawn on a CAD model. The target points, sliced edges, and the drawn paths corresponding to the point-, feature-, drawing-based approaches are imported into the robot specific software to generate the TPP. A further detailed description of each approach along with the flow-chart is provided in the following sections.

## 2.1. Point-based approach

The point-based approach considers the coordinate positions of the vertices within a CAD model. This approach assumes that the CAD model possesses a regular and simple shape, and the deposition of the tracks and layers will maintain consistent profiles. The start and the end instructions for the welding torch for different layers are inserted separately. Following algorithm outlines the steps involved for the point-based approach.

**Step 1. Input parameters**

- Dimension of the CAD model: length (L), breadth (B), and height (H)
- Suitable process parameter: PTS and WFR
- Single track dimension: track width (w) and layer height (h)

**Step 2. Input hatch spacing (δ)**

**Step 3. To determine number of layers ($n_L$) and tracks ($n_T$)**

- $n_L = (H/h)$
- $n_T = (L/\delta)$

**Step 4. To discretize each layer into points**

- Start point: S ($x_s$, $y_s$, $z_s$)
- Discretized points:
  P [$x_s$, +(i-1) δ, $y_s$+ B, $z_s$], Q [$x_s$, +(i-1) δ, $y_s$, $z_s$] where I = 1,2, 3...$n_T$

**Step 5. To register points into tool centre point (TCP)**

- Convert the Cartesian coordinate (x, y, z) of each point into TCP (x, y, z, w, p, r), where w, p and r are rotational angles about the x-, y-, and z-axes, respectively.

**Step 6. To import registered points into the robot specific software**

- Target points act as the path

**Step 7. To generate robot program**

- Robot code generation with suitable process parameters WFR and PTS

**Step 8. To simulate virtual deposition**

- Virtual deposition simulation to ensure correctness of the robot path program

**Step 9. Output teach pendant program (TPP)**

- Virtual Transfer TPP to teach pendant for dry run before final execution

**Fig. 2** shows the flowchart of the point-based approach, which is constructed based on the aforementioned algorithm.

In summary, the point-based approach offers notable advantages including simplified path programming and expedited generation of robot code. The utilization of a generalized Python code for discretizing CAD models adds another layer of flexibility, enabling a seamless adaptation to changes in input parameters. However, this method is constrained to the fabrication of simple and regular shapes. It is tedious and often extremely difficult to find out the coordinate of the starting point for each layer for curvilinear geometry. The number of points also increases for non-linear paths leading to a higher volume of lines in the robot program. In turn, the robotic system is constrained by teach pendant memory limitations. For parts with either regular or irregular shapes, the feature-based approach offers a more suitable solution, as elaborated in the subsequent section

## 2.2. Feature-based approach

The initial assumptions regarding single-track deposition parameters, the number of tracks, the number of layers, and hatch spacing calculations in the feature-based approach align with those in the point-based approach. However, the feature-based approach provides a capability to generate linear track paths for both regular and irregular shapes with a greater ease. It involves the definition of cutting planes for horizontally slicing the CAD model based on the layer height, and for each sliced layer, cutting planes are established in the vertical direction, considering the hatch spacing. The start and the end points of the welding torch are specified at the corners of each horizontally sliced layer, which is changeable for different layers. Following algorithm outlines the steps involved for the development of a scanning strategy using feature-based approach.

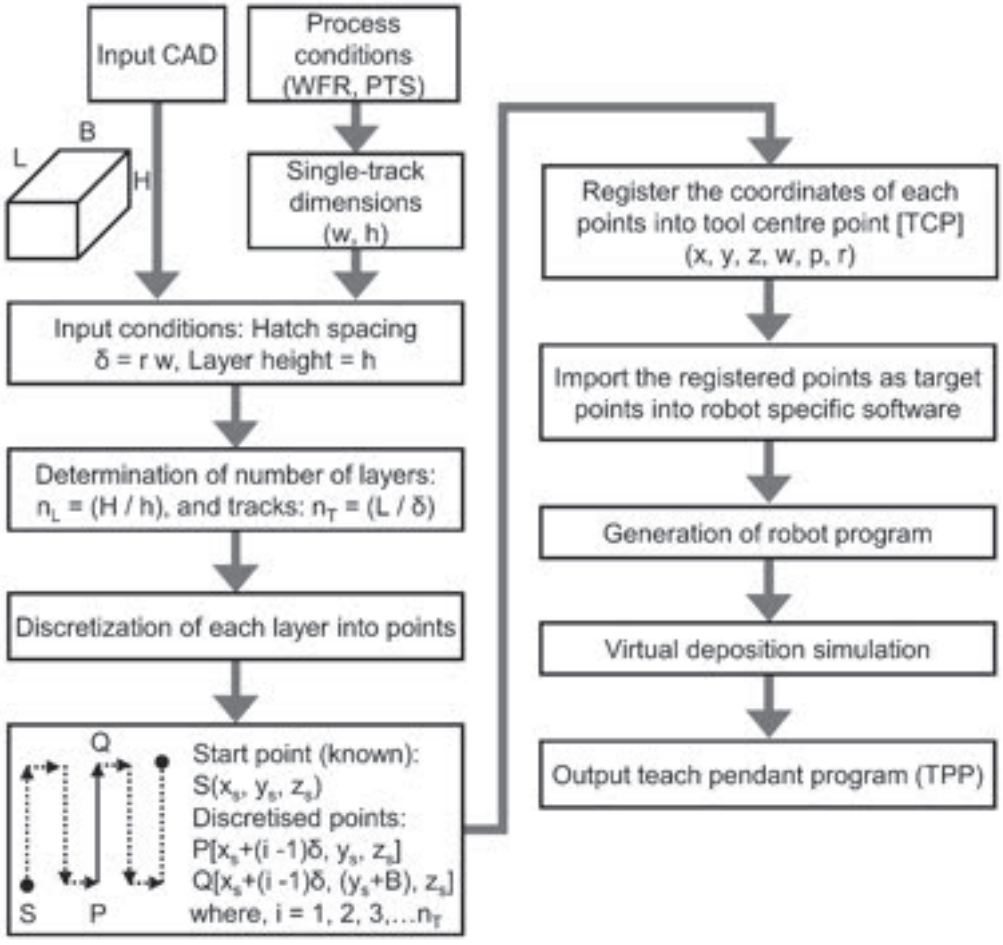


**Fig. 2 : Flow chart of the point-based approach**

**Step 1. Input parameters**

- Dimension of the CAD model: length (L), breadth (B), and height (H)
- Suitable process parameter: PTS and WFR
- Single track deposit dimension: track width (w) and layer height (h)

**Step 2. Input hatch spacing (δ)**

**Step 3. To slice the CAD model to layers with horizontal cutting planes**

- Horizontal cutting planes: z = i* h;i = 1, 2, 3…($n_L$-1), where $n_L$= (H/h)

**Step 4. To slice each layer with vertical cutting planes**

- Horizontal cutting planes: x = j * δ; j = 1, 2, 3… ($n_T$-1), where $n_T$= (L/ δ)

**Step 5. To import sliced CAD model into the robot specific software**

- Layer-wise importing is necessary to accommodate varying arc start and end locations for different layers.

**Step 6. To create feature along the cutting edges**

- Path planning using the feature based on the scanning strategy

**Step 7. To generate robot program**

- Robot code generation with suitable process parameters WFR and PTS

**Step 8. To simulate virtual deposition**

- Virtual deposition simulation to ensure correctness of the robot path program

**Step 9. Output teach pendant program (TPP)**

- Transfer the TPP into teach pendant for the dry run before final execution

**Fig. 3** shows the flowchart of the feature-based approach, which is constructed based on the aforementioned algorithm.

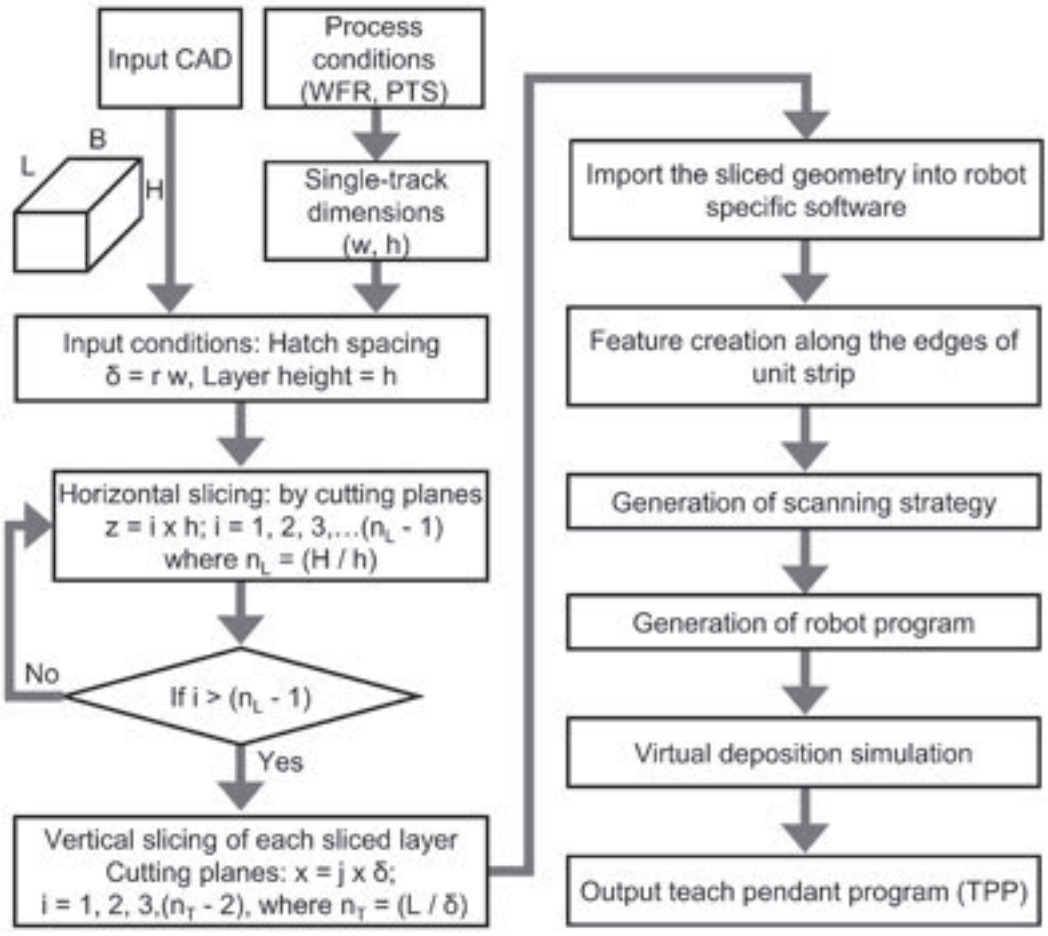


**Fig. 3 : Flow chart of the feature-based approach.**

The sliced CAD geometry in IGES (Initial Graphics Exchange Specification) format needs to be exported in robot specific software. This format ensures that cutting edges are easily detected, simplifying the process of feature creation. The mathematical concept of the cutting plane is given in the Appendix-I. The benefits of this approach lie in its ability to offer tailored path planning for parts of regular and irregular shapes. Adaptive layer height can be possible by considering of suitable cutting planes during horizontal slicing. However, it's important to note that in irregular shapes, aligning the non-linear path with the deposition path can result in multiple arc start and end points during the deposition process. This can adversely affect dimensional consistency.

## 2.3. Drawing-based approach

The drawing-based approach offers the flexibility to employ non-linear scanning strategies. This approach assumes that the contour of the part to be deposited can be drawn directly onto the CAD model of the substrate. The contour of the horizontally sliced CAD model of the deposition part is necessary to accommodate varying arc start and end points for each layer. Following algorithm outlines the steps involved for the development of a scanning strategy using drawing-based approach.

**Step 1. Input parameters**

- Dimension of the CAD model: length (L), breadth (B), and height (H)
- Suitable process parameter: PTS and WFR
- Single track deposit dimension: track width (w) and layer height (h)

**Step 2. Input hatch spacing (δ)**

**Step 3. To determine number of layers ($n_L$) and tracks ($n_T$)**

- $n_L = (H/h)$
- $n_T = (L/\delta)$

**Step 4. To draw path along the contour of the CAD model**

- Tracks to be drawn on the surface of substrate

**Step 5. To import drawn feature into the robot specific software**

- Layer-wise drawing is necessary to accommodate varying arc start and end locations for different layers.

**Step 6. To generate robotic tool path along the drawn feature**

- Path planning using drawn feature based on the scanning strategy

**Step 7. To generate robot program**

- Robot code generation with suitable process parameters WFR and PTS

**Step 8. To simulate virtual deposition**

- Virtual deposition simulation to ensure correctness of the robot path program

**Step 9. Output teach pendant program (TPP)**

- Transfer the TPP into teach pendant for the dry run before execution

**Fig. 4** shows the flowchart of the drawing-based approach based on the aforementioned algorithm that assumes the non-linearity of the CAD model along the deposition direction only. For the regular shape, the depositing paths are drawn on the substrate only once, which is given by an offset for successive layers further. In contrast, the depositing paths are drawn for each layer for the irregular shape along the build height.

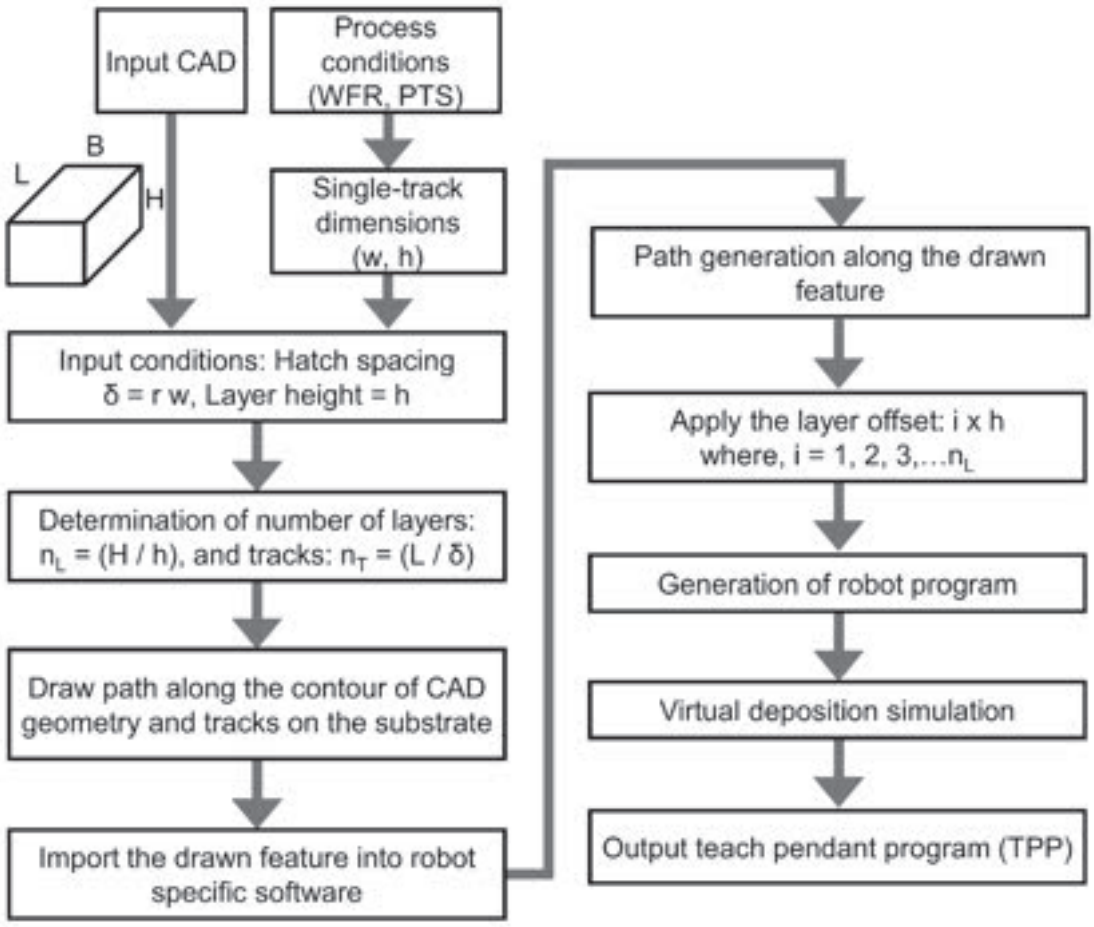


**Fig. 4 : Flow chart of the drawing-based approach**

The merits of this approach lie in its ability to perform path planning based on drawn features and its versatility in accommodating both linear and non-linear track configurations. It is particularly well-suited for regular shapes and offers manual operation with the potential for automation. However, while this approach excels in handling non-linear tracks, its superiority over the feature-based approach is depends upon the orientation of the deposition part.

## 3.0 RESULTS AND DISCUSSION

The relative efficacy of the three proposed CAD-to-Print approaches is evaluated for a single-track multi-layer thin linear wall and multi-track multi-layer non-linear build deposition based on the computational time, complexity of the robot program, software involvement, and user intervention.

### 3.1. Single-track multi-layer linear wall

**Fig. 5(a-c)** show the generated scanning strategy for the single-track five-layer wall using the point-based, feature-based and drawing-based approaches, respectively. Given a CAD model with dimensions of 100 mm (length), 10 mm (height), and 5 mm (width), and considering a track length of 100 mm, a layer height of 2 mm, and width of 5 mm, there are 5 layers and 1 track in total. A bidirectional scanning strategy is considered that usually results in an improved dimensional consistency [21].

**Fig. 5(a)** shows the robot scan path following point-based approach for a single-track five-layer linear wall. Each layer is linked with the discretized points at the ends as shown by the blue colour dots in **Fig. 5(a)**. The blue dots show the deposition start and end points for a particular layer. The

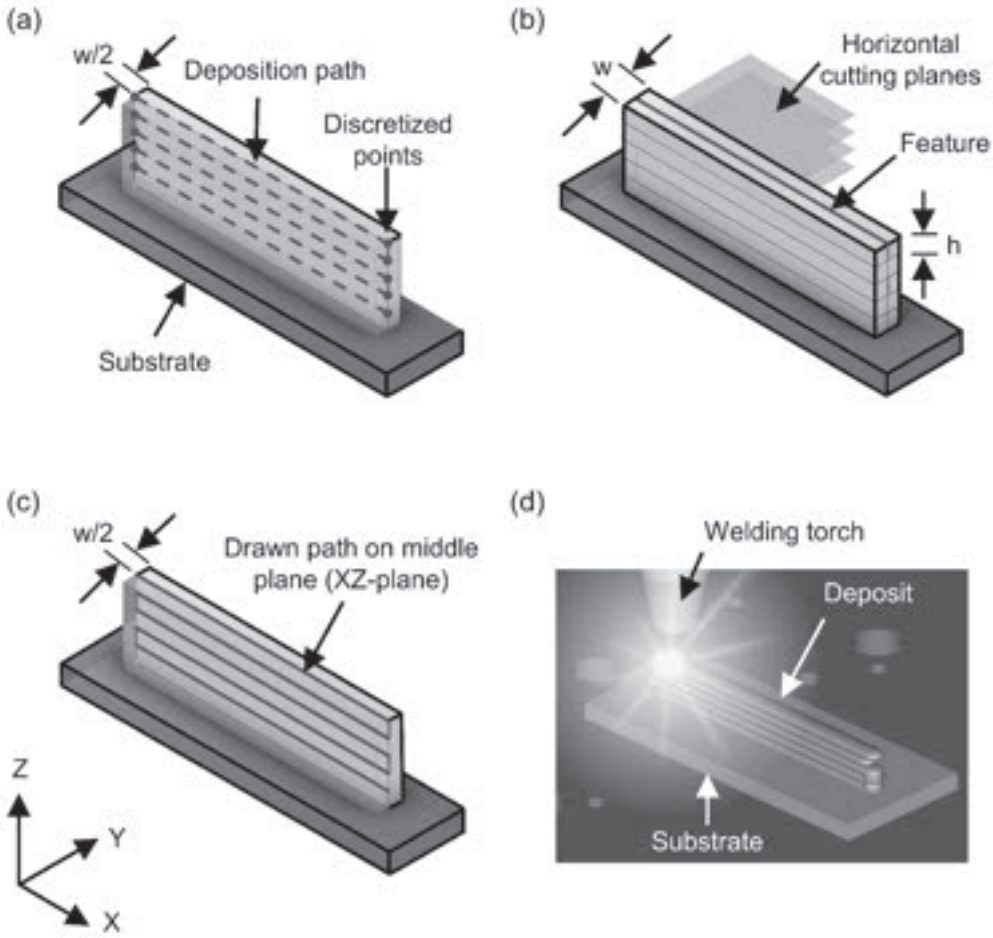


**Fig. 5 : (a-c) Path generation for single-track five-layer wall deposition using (a) point-based, (b) feature-based and (c) drawing-based approaches; (d) virtual deposition simulation of linear wall. w and h are the single-track width and height, respectively.**

depositing and non-depositing paths are represented by the blue dashed and red solid lines, respectively. In this bidirectional scanning strategy, a minimum of one point is necessary for every change in direction, resulting in ten discretized points for five layers as shown in **Fig. 5(a)**.

**Fig. 5(b)** shows the sliced CAD geometry of the single-track five-layer linear wall and the substrate, in which the deposition path is developed using feature-based approach shown by solid blue colour line at the middle. The CAD model of the wall is sliced vertically using the horizontal cutting planes (xy-plane) as shown in **Fig. 5(b)**. These horizontal cutting planes are at the distance of preset layer height (h) which is equal to the single-track height at certain WFR and PTS.

**Fig. 5(c)** shows the CAD geometry of the single-track five-layer linear wall and the substrate, in which the deposition path shown by blue line is developed using the drawing-based approach. A longitudinal vertical cutting plane (xz-plane) is positioned along the half-width (w/2) of the CAD geometry of the wall to facilitate the symmetry for drawing path at the middle vertical plane. The deposition path is traced from bottom to top in a layer-wise manner (**Fig. 5c**), assuming a constant layer height (h), which streamlines the path generation process in the robot-specific software.

**Fig. 5(d)** shows an image from the virtual simulation of the single-track five-layer wall deposition to validate the generated robot program before converting it into TPP. The deposition related instructions such as arc-on, arc-off and wait time need to be checked during the virtual simulation. The generated path program is required to be modified in case of any perturbation in the scanning strategy and positional accuracy of welding torch. It is noted that the simulation time for all three approaches is approximately 30 seconds, assuming a printing travel speed of 20 mm/sec.

**Table 1** presents a comparison of the performance indices for the three approaches such as the CPU time, program length, ease for program modification and software involvement. The CPU time is measured as the total time taken by software involvement, includes the Python script, CAD software, and robot-specific software on a 16-core computer. The point-based approach requires less CPU time because the scan path is automatically generated by a Python script. In contrast, it is done manually in the feature- and drawing-based approaches. Therefore, if any changes are needed in the dimensions of the CAD geometry, it is easier to regenerate the path with the point-based approach.

Overall, the point-based approach is the best for simple single-track multi-layer wall deposition. However, it is not suitable for complex irregular geometries because finding the starting point on the edge of the CAD model for the welding torch on each layer is challenging. Additionally, a huge number of discretized points are generated for the larger CAD models, which makes the manual insertion of weld instructions in robot-specific software becomes difficult and time-consuming consequently. The feature- and drawing-based methods are more practical and easier for multi-track multi-layer builds, as explained in the following section.

**Table 1 : Comparison of performance indices of three CAD-to-Print approaches for single-track multi-layer linear wall deposition**

| Performance index | Point-based | Feature-based | Drawing-based |
|---|---|---|---|
| CPU time | 17 min | 23 min | 25 min |
| Robot program length | 114 lines | 100 lines | 100 lines |
| Insertion of weld related instruction | Manually added | Automatic | Automatic |
| Generation of path | Easier | Easy | Difficult |
| Regeneration of the path If any modification in the CAD geometry | Easier | Easy | Difficult |
| Software involvement | CAD and robot specific software, Python language for discretization | CAD and robot specific software | CAD and robot specific software |

### 3.2. Multi-track multi-layer non-linear build

To evaluate the capabilities of the feature- and drawing-based approaches, the multi-track multi-layer non-linear build is selected for this study.

**Fig. 6(a-b)** show the generated robot scan paths for the multi-track multi-layer non-linear builds using a feature-based approach with different orientations of vertical cutting planes in xz- and yz-planes, respectively. The orientation of the horizontal cutting planes is same in xy-plane for slicing of the build in multiple layers as shown in **Figs 6(a-b)**. The non-linear edge of the CAD model is assumed as the following mathematical expression of a sine curve,

$$y = \mathrm{A} \sin\left(\frac{2\pi}{\lambda}\right) x \quad \text{..... 1}$$

where, A and λ are the amplitude and wavelength of the sine curve, respectively, with the assumed values of 10 mm and 100 mm. The dimensions of the given CAD geometrical model are 100 mm (length), 10 mm (height), and 25 mm (width). As the assumed single-track height is 2 mm, the total number of layers are five to achieve the total height of 10 mm. Considering the assumed values of the single-track width as 5 mm, the hatch spacing is estimated around 3.1 mm for multi-track depositions [20]. The number of tracks vary according to the orientation of the vertical planes as shown in **Fig. 6(a)** and **6(b)**. A bidirectional scanning strategy is adopted for both tracks and layers. The depositing and non-depositing paths are illustrated by the blue and red solid lines, respectively **(Fig. 6 (a-b))**.

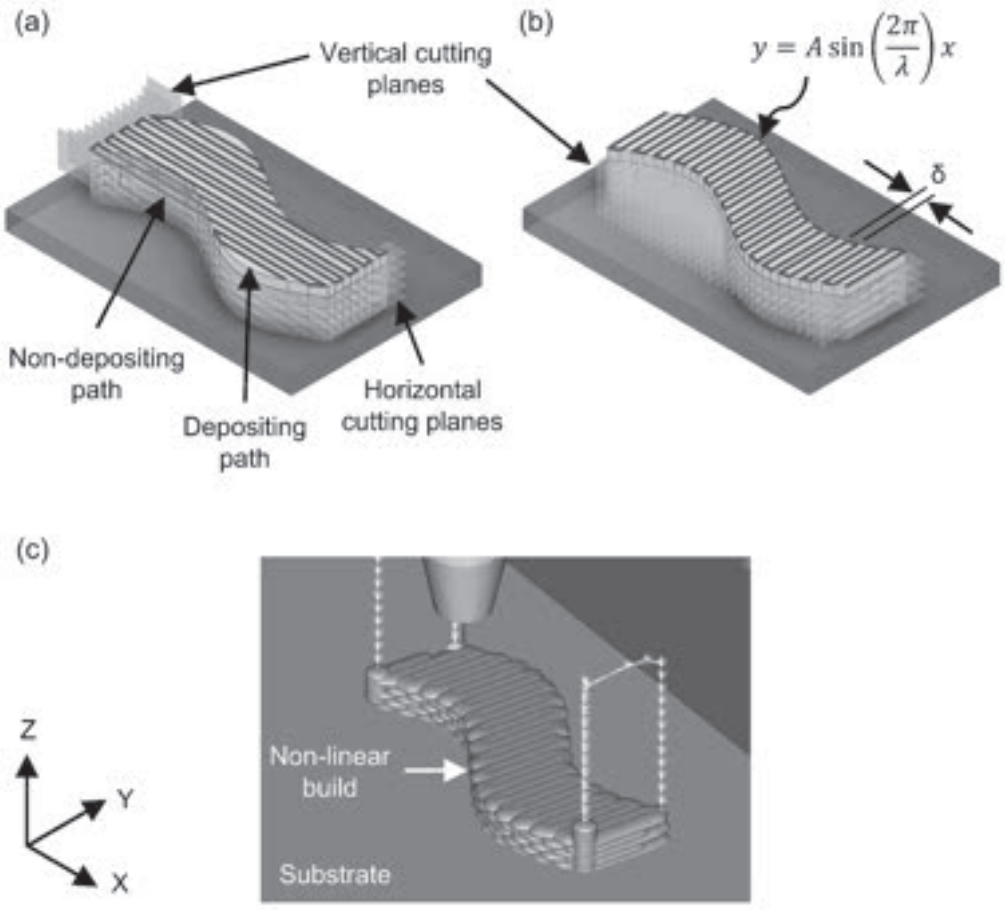


**Fig. 6 : (a-b) Path generation for multi-track multi-layer non-linear build deposition using feature-based approach with different orientations of vertical cutting planes; (c) virtual deposition simulation of non-linear build using suitable feature-based approach.**

**Fig. 6(a)** shows the scan paths developed by using feature-based approach considering the xz-planes as the vertical cutting planes. With a CAD bounding box width of 45 mm and a hatch spacing of 3.1 mm, a total of fourteen bidirectional tracks are generated utilizing thirteen cutting planes as shown in **Fig. 6(a)**. However, due to the non-linearity of the CAD model along the deposition path, the track length of 100 mm is interrupted at the curved region. This interruption results in multiple starts and stops of the welding torch during the actual deposition process leading to dimensional inconsistency, hump and crater defects [1]. To avoid these issues, alternative approaches for vertical slicing is being explored and presented further.

**Fig. 6(b**) shows the scanning strategy developed by using the feature-based approach considering the yz-planes as the vertical cutting planes. This configuration generates a total of thirty-two bidirectional tracks by employing thirty-one cutting planes, with each track having a length of 25 mm along y-axis **(Fig. 6(b))**. In comparison to the generated deposition path in **Fig. 6(a)**, this approach is likely to provide better dimensional consistency due to lesser number of start and end events of the welding torch as shown in **Fig. 6(b)**.

**Fig. 6(c)** shows the image captured from the virtual simulation of the thirty-two tracks and five layers to validate robot program generated using the feature-based approach as shown in **Fig. 6 (b**). After the arc end event, the torch is uplifted to safe height of 50 mm in z-direction **(Fig. 6(c))** to avoid any collision with the already deposited tracks / layers. Notably, the simulation time for this approach is approximately 266 seconds, assuming a printing travel speed of 20 mm/sec.

The feature-based approach encounters limitations when the torch needs to traverse along a curvilinear path. In such cases, the drawing-based approach emerges as a viable alternative. Below, the drawing-based approach tailored for multi-track multi-layer non-linear builds is presented.

**Fig. 7(a)** shows the scan paths generated by the drawing-based approach. With the same CAD model of dimensions 100 mm (length) x 10 mm (height) x 25 mm (width), and a hatch spacing of 3.1 mm, a total of eight bidirectional tracks are drawn on the CAD surface according to the sine curve outlined in equation (1), and shown by solid blue colour line in **Fig. 7(a)**. As a result of the change in the deposition direction, as shown in **Fig. 7(a)**, the length of a particular track equals to around 109.2 mm. A similar bidirectional scanning strategy is considered for both the tracks and layers. **Fig. 7(b)** shows the virtual simulation of eight-track five-layer non-linear build deposition, which is programmed using the drawing-based approach as shown in **Fig. 7(a)**. A better dimensional consistency probably achieved by torch path along the non-linear path and bi-directional tracks and layers.

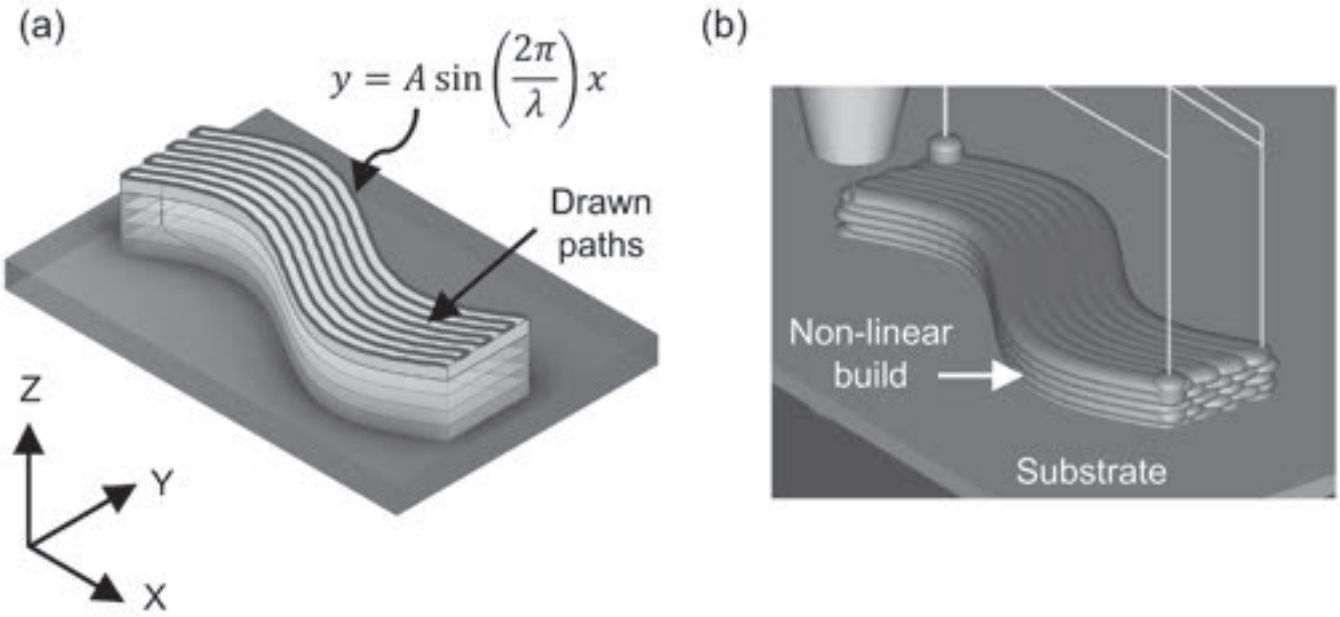


**Fig. 7 : (a) Path generation for multi-track multi-layer using drawing-based approach; (b) virtual deposition simulation of non-linear build deposition.**

**Table 2 : Comparison of performance indices of two CAD-to-Print approaches for multi-track multi-layer non-linear build deposition**

| Performance index | Feature-based | Drawing-based |
|---|---|---|
| CPU time | 350 min | 400 min |
| Robot program length | 560 lines | 1215 lines |
| Insertion of weld related instruction | Automatic | |
| Generation of path | Easy | |
| Regeneration of the path if any modification in the CAD geometry | Easy | |
| Software involvement | CAD and robot specific software | |

**Table 2** presents a comparison of significant performance indices for the multi-track multi-layer non-linear build deposition using suitable feature- and drawing-based approach. The CPU time and program length in drawing-based approach is more as compared to the feature-based approach due to a greater number of points required along the curvilinear path.

### 3.3. Dimensional comparison between CAD geometry and actual deposit

To examine the efficacy of the different CAD-to-Print approaches, sample single-track multi-layer wall and multi-track multi-layer non-linear builds are deposited on a 6 mm thick AA6061 aluminium alloy substrate using a 1 mm diameter filler wire of AA5356. An advanced GMA power source (Fronius 500 TPSi) is used for preparing the sample depositions. A six-axis FANUC robot (Arc Mate 100iD/8L) with a stationary two-axis positioner is used to move the welding torch along the scan path generated using different approaches. The welding torch is kept perpendicular throughout the deposition. All deposits are prepared at a WFR of 11 m/min, a PTS of 20 mm/s, an interpass temperature of 373 K and Ar (99.999 % purity)as a shielding gas at a flow rate of 15 l/min.

**Fig. 8(a)** shows the single-track five-layer wall deposit, which is compared with the CAD geometry of the deposit. Similarly, **Fig. 8(b-c)** show the multi-track five-layer deposit prepared using feature-based **(Fig. 6(c))** and drawing-based **(Fig. 7(b))** approaches, respectively. The length, width and height of the actually deposited wall are measured at five different locations, and the average value is considered for the comparison with the corresponding dimensions of the CAD model.

**Table 3** shows the comparison between the dimensions of CAD model and actual deposit for single-track five-layer wall **(Fig. 8(a))** and multi-track five-layer build **(Figs. 8(b-c))**. Following points are noteworthy. Firstly, the measured wall height is found lesser than the CAD height by 30%, which is attributed to the partial remelting of the previously deposited layer and flow of molten metal over its curved surface. This huge difference in the height can be mitigated by the adaptive

**Table 3 : Dimensional comparison between the CAD model and the actual deposit**

| | Single-track Five Layer Wall | | | Multi-track Five Layer Wall | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Feature-based | | | Drawing-based | | |
| | Length | Width | Height | Length | Width | Height | Length | Width | Height |
| CAD dimension(mm) | 100 | 5 | 10 | 100 | 25 | 10 | 100 | 25 | 10 |
| Deposit dimension (mm) | 105.7 (±0.3) | 5.2 (±0.2) | 7.0 (±0.3) | 105.0 (±0.9) | 27.9 (±1.1) | 10.4 (±0.3) | 103.5 (±0.8) | 25.5 (±1.1) | 12.3 (±1.2) |
| Deviation (%) | 6 | 4 | -30 | 5 | 11 | 4 | 4 | 2 | 23 |

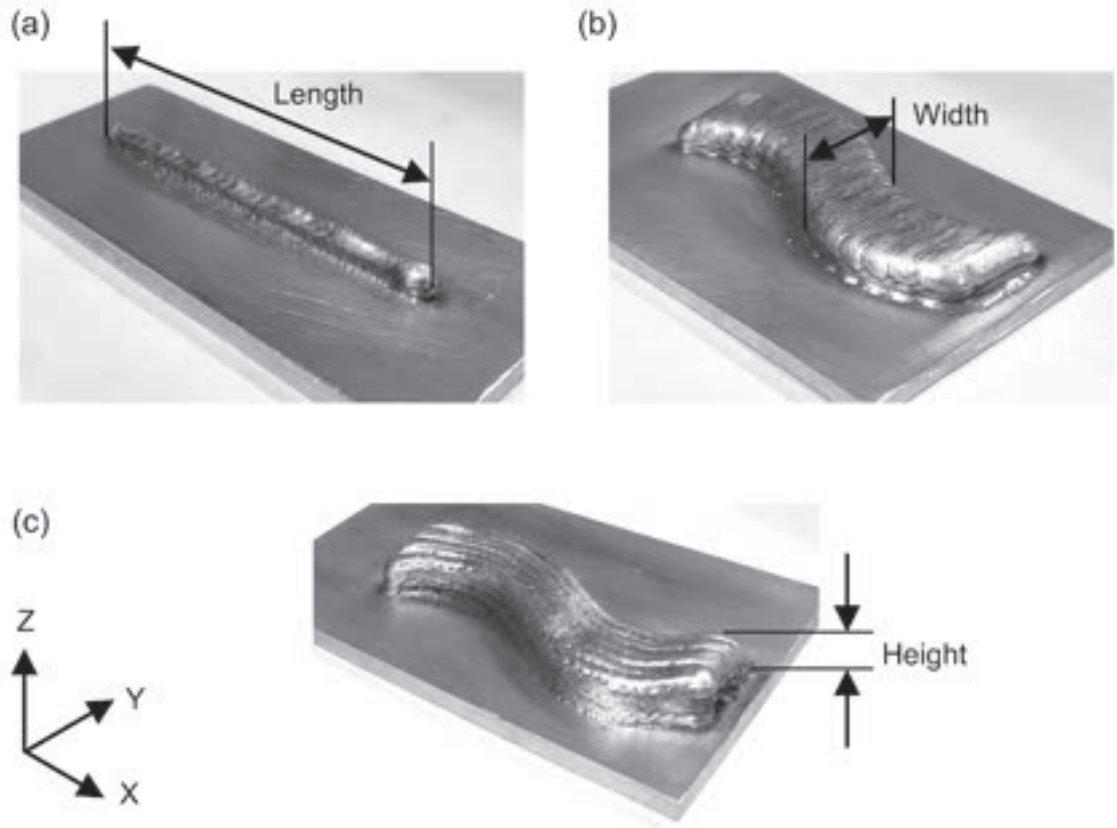


**Fig. 8 : Deposited (a-c) single-track multi-layer wall and multi-track multi-layer non-linear builds shown in Fig.5(d), Fig. 6(c) and Fig, 7(b), respectively.**

layer height considering the remelting of previous layer. Secondly, the feature-based approach provides lesser deviation with the CAD model in comparison with the drawing-based approach for multi-track multi-layer build. Thirdly, the multi-track multi-layer build achieves greater height than the single-track multi-layer build for the same number of layers **(Table 3)**, which is attributed to the restricted flow of the molten metal during multi-track deposition [22].

## 4. 0 SUMMARY AND CONCLUSIONS

In summary, three strategies are presented here for easy-to-use CAD-to-Print solution for robotic GMA-DED. The point-based approach stands out as the most efficient option for regular simple shapes, demanding minimal pre-processing time. In contrast, the feature-based approach excels for the printing of irregular shapes with linear paths. The drawing-based approach can be a substantive one for printing of parts requiring curvilinear paths. Following are the main conclusions of this work.

- Integration of a robot specific software with an open source CAD software is an effective route for effective path planning for robotic GMA-DED of a part. The same can be automated further for any complex part geometry.
- The overall percentage difference between the dimensions of CAD geometry and actual deposit are found minimum for the feature-based approach.
- A knowledge of the effect of the important process conditions such as wire feed rate, printing travel speed, hatch spacing and scanning strategy on the dimensional consistency of the deposition profile is a must for a successful CAD-to-Print operation with GMA-DED.

## ACKNOWLEDGEMENT

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## APPENDIX- I

**Fig. I** illustrates the cutting plane (P) represented by the hatched region. Point A is positioned at coordinates ($x_a$, $y_a$, $z_a$), while point B lies on the plane with coordinates ($x_b$, $y_b$, $z_b$). We can formulate the equation for the cutting plane perpendicular to the edge line AB, passing through point B, as expressed in the equation 1. The cutting plane in any given direction can be determined using equation 2.

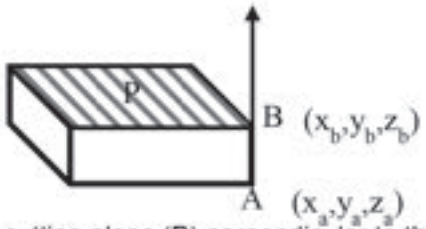


Fig. I: Illustration of cutting plane (P) perpendicular to the vector AB.

$$(x_b - x_a)(x - x_b) + (y_b - y_a)(y - y_b) + (z_b - z_a)(z - z_b) = 0 \quad (1)$$

$$P' = M_x M_y M_z P \quad (2)$$

where,

$$M_x = \begin{pmatrix} 1 & 0 & 0 \\ 0 & \cos\alpha & -\sin\alpha \\ 0 & \sin\alpha & \cos\alpha \end{pmatrix} \quad (3)$$

$$M_y = \begin{pmatrix} \cos\beta & 0 & \sin\beta \\ 0 & 1 & 0 \\ -\sin\beta & 0 & \cos\beta \end{pmatrix} \quad (4)$$

$$M_z = \begin{pmatrix} \cos\gamma & -\sin\gamma & 0 \\ \sin\gamma & \cos\gamma & 0 \\ 0 & 0 & 1 \end{pmatrix} \quad (5)$$

where, α, β, γ represent the angles of the plane with respect to the x, y, and z-axes, respectively.

# Resisting Corrosion under Chloride Environment by Providing Duplex Stainless Steel Cladding Through FCAW

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## Abstract

Cladding is one of the solutions usually resorted to protect a structure from the detrimental effect of its surrounding environment. This investigation concerns with covering of duplex stainless steel on low carbon steel through flux cored arc welding (FCAW) under different parametric settings. Microstructure is observed and corrosion test under chloride environment is undertaken to find out resistance to corrosion of cladding. Corrosion becomes quite low at 0.38 kJ/mm heat input. At this condition, welding speed was also at a higher side. Therefore, the corresponding combination of parameters would be adopted for getting extended service life of a structure.

**Keywords:** Welding, FCAW, cladding, duplex stainless steel, corrosion

## 1.0 Introduction

For protecting a structure open to corrosive atmosphere, a wear-resistant covering is usually employed [1-4]. This covering resists corrosion wear to enhance life of operation and reduces maintenance cost remarkably [5-10]. Apart from different techniques used, weld cladding employing an arc is quite common. Clad material is superior in nature than the base material in terms of its alloy content. Therefore, weld cladding is essentially a dissimilar welding process. While some solid state welding can be employed for weld cladding, many arc welding processes are employed to have been popularly used for this [2,7,8,11] and Gas Metal Arc Welding (GMAW) equipment can be put to use [1,6-8,12-14] for cladding effectively.

Saha and Das [1] discussed extensively the effect of process variables on the characteristics, microstructure and corrosion resistance properties of clad parts made using GMAW. They also stated GMAW to be easily employed for cladding. Weld bead geometry is important to set the process towards deposition of an appropriate clad layer [12-21]. Clad layer was employed for repairing [5, 8]. Investigation on bead geometry was carried out by many [6, 12-18, 22, 23]. Kannan and Yoganandh [6] carried out an experimental investigation, and proposed a mathematical model to predict bead profile with GMAW process parameters satisfactorily. Low carbon steel clad with Austenitic stainless steel was done at different conditions effectively [12]. Murugan and Parmar [14] predicted successfully geometry of stainless steel weld bead while, optimal geometry of bead was obtained [16] in a work done using tungsten inert gas (TIG) welding of stainless steel. Shape of weld bead is the result of selection of heat input and duplex stainless steel was deposited [17] on low carbon steel effectively at a condition. To predict dilution and bead profile made through GMAW, models were successfully developed by Palani and Murugan [18].

Saha et al. [22] found minimum corrosion rate at 0.49 kJ/mm heat input. Increased heat input results in reduction of ferrite

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phase exhibiting more corrosion. On the other hand, Bose and Das [23] investigated on corrosion resistance of γ-stainless steel cladding and 0.6 kJ/mm heat input provided quite low corrosion. A number of research groups [24-41] performed deposition of different materials to retard corrosion. Nitrogen, etc. were added in a related work group also [26-35]. Duplex stainless steel showed better resistance to corrosion than that of austenitic stainless steel [37-44]. In the experiments conducted by Das and Saha [31], nickel plated medium carbon steel was covered with austenitic stainless steel to report improved resistance to corrosion. Bose and Das [32] employed PTIG (pulsed TIG) welding and recommended 0.594 kJ/mm heat input as the appropriate condition for minimum corrosion rate.

Weld deposit with higher heat input showed more impact toughness in another work [41]. With increased heat input, reduction in the corrosion resistant was observed. Again, corrosion resistance increased with increased percentage of argon in the shielding gas. Saha and others [42, 43] used duplex stainless steel filler material for depositing single clad layer to report high corrosion resistance of them. Kannan and Murugan [44] carried out an experimental work to report dilution, penetration, reinforcement and bead width to have increased with an increase in weld current.

In this work, characteristics of duplex stainless steel cladding was investigated under a set of varying process parameters. The clad specimens would next be subjected to immersion-type corrosion test under chloride environment to facilitate choose the suitable set of process parameters giving the least rate of corrosion.

## 2.0 Materials and Method

An ESAB, India manufactured AutoK400 MIG / MAG welding machine is used in this work as shown in **Fig. 1**. Pure $CO_2$ gas is employed for shielding the weld region. The torch has been fitted on a speed controllable vehicle. Straight linear motion is obtained as it follows a guided path. Velocity of it can be set at different values within a range. Shielding gas discharge is kept constant at 18 l/min. Low carbon steel base plates having the composition detailed in **Table 1** have the size of 100mm× 50mm× 6mm. Successive beads have 50% overlap. 6 passes are made to cover the sizeable portion of the specimen. Weld voltage and weld current are chosen suitably to determine heat input (HI) following standard relationship [24, 25]. Duplex Stainless Steel (**Table 2**) is taken as the clad material. Four experimental runs are conducted in this work at four values of heat input as detailed in **Table 3**.

**Table 1** and **Table 2** show composition of substrate and filler wire respectively. Carbon, silicon, manganese, chromium, molybdenum and nickel content of duplex stainless steel filler wire (E2209T0-1) is remarkably higher than that of the base plate. The electrode wire contains nitrogen (0.125%) to boost precipitation of austenitic phase and also to stabilize it, thus improving mechanical properties of stainless steels [27-35]. Ferrite phase of this steel offers better corrosion resistance than the γ-phase.

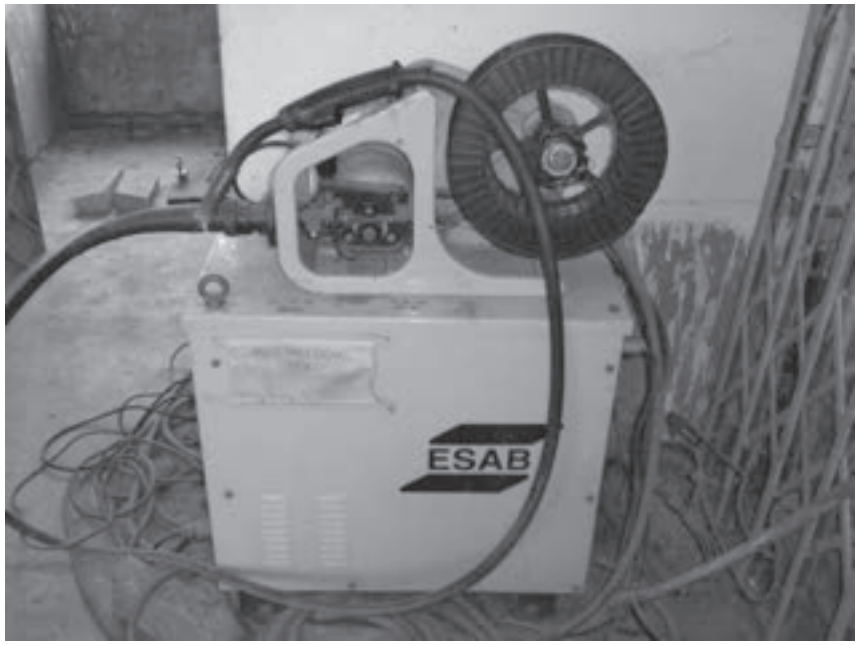



**Fig. 1 : The MIG/MAG welding set up**

**Table 1 : Contents of substrate**

| %C | %Si | %Mn | %P | %S | %As | %Zn | %Ni | %Ta |
|---|---|---|---|---|---|---|---|---|
| 0.076 | 0.138 | 0.343 | 0.128 | 0.063 | 0.068 | 0.015 | 0.012 | 0.011 |

**Table 2 : Contents of filler wire (E2209T0-1)**

| % C | % Cr | % Ni | % Mo | % Mn | % Si | % N | % P | % S |
|---|---|---|---|---|---|---|---|---|
| 0.020 | 22.52 | 9.09 | 2.91 | 1.01 | 0.76 | 0.125 | 0.018 | 0.009 |

Test for hardness at the surface of the base plates is carried out before and after cladding by using a Fine Testing Machine, Miraj made Rockwell Hardness Testing Machine. Hardness value has been found in Rockwell hardness B scale by applying a load of 100kg. The geometry of the weld bead is then determined as it affects mechanical property of the weld, and thus, affecting its quality [16]. Clad plates are cut at different sections for preparing samples to observe under a tool makers microscope (Mitutoyo, Japan made). First, cut samples are filed and surface ground. Then they are ground/polished on a belt grinder/polisher and ground and polished on a disc grinder/polisher. Final stage is to undertake buffing operation using a velvet cloth and alumina paste on disc grinder/polisher to make the surface mirror finished. Respective values of reinforcement and penetration for each specimen are noted, and percentage dilution (D% = (B/(A+B)) x 100%) is calculated when, B is area of the weld pool, and A= area of the weld above the surface of the base metal. With some assumptions, dilution may also be computed as ({P/(P+R)} x 100%), when P is depth of penetration and R is height of reinforcement. In this work, it is used to compute dilution.

Metallographic study is carried out on the clad specimens by etching using Kalling's No. 2 reagent. It is prepared by mixing 100ml ethanol, 100ml HCL, and 5gm $CuCl_2$. Microstructures are observed using a Metzer, India made metallurgical microscope at 200x magnification. Corrosion test is next performed on different samples of polished clad components. Samples are weighed with a precision of 1µg. Hydrochloric acid, anhydrous ferric chloride, and distilled water mixture is used as a solution for the corrosion test. Only clad portions of the test specimens are made exposed to the solution and the remaining portion is masked with Teflon tape. Samples are put inside the solution for a day for accelerated corrosion test. Thereafter, they are taken out and washed under running water and put under ethyl alcohol. After taking out, they are dried and their weights are measured to calculate corrosion rate per unit area per time.

## 3.0 Results and Discussion

Detail of four experimental runs can be seen in **Table 3**. Radius of curvature of the weld cladded flats and distortion value are also shown. Angular distortion increases with heat input. Higher the heat input, larger will be the melt volume of the weld zone and this would cause larger shrinkage upon solidification and have larger distortion. Hardness of clad region has higher hardness than the unclad portion as expected (**Table 4**). This hardness increment in cladding is likely to be due to the presence of alloying elements like Cr, Ni, Mo, Mn, Si and N which increase hardenability of steels. Reinforcement, penetration and dilution are listed in **Table 5**.

**Table 3 : Heat input used for weld cladding with 6 passes**

| Sl. No | Weld Voltage (V) | Weld Current (A) | Torch travel speed (mm/min) | Heat input, (kJ/mm) | Radius of curvature (mm) | Distortion angle (°) |
|---|---|---|---|---|---|---|
| 1 | 28 | 145 | 540 | 0.36 | 347.29 | 7.1 |
| 2 | 28 | 145 | 516 | 0.38 | 265.87 | 8.2 |
| 3 | 28 | 145 | 468 | 0.42 | 257.49 | 10.5 |
| 4 | 26 | 145 | 402 | 0.45 | 135.15 | 15.5 |

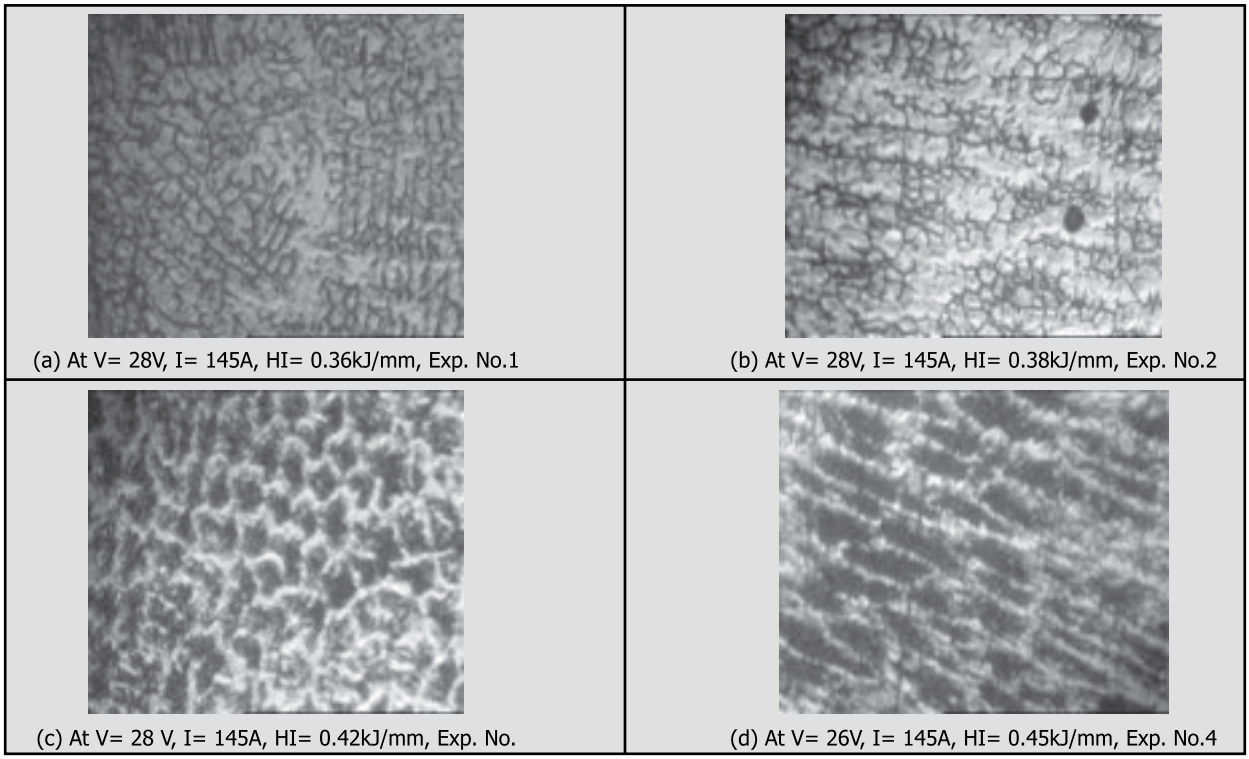
**Table 4 : Hardness values measured before and after cladding**

| Sl. No. | Hardness in HRB | |
|---|---|---|
| | Before cladding | On the cladding |
| 1 | 73 | 87 |

**Table 5 : Dilution of base plate after cladding**

| Sl. No | Heat input, (kJ/mm) | Depth of penetration, P (mm) | Reinforcement, R (mm) | % Dilution $\left[\frac{P}{(R+P)}\right] \times 100$ |
|---|---|---|---|---|
| 1 | 0.36 | 0.22 | 1.75 | 11 |
| 2 | 0.38 | 0.16 | 1.91 | 7.7 |
| 3 | 0.42 | 0.06 | 2.09 | 8.2 |
| 4 | 0.45 | 0.1 | 2.57 | 3.7 |

In **Fig.2**, microstructures obtained under different parametric combinations are depicted. The microstructure depicted in **Fig.2 (a),(b)** show the precipitation of single phase white ferrite (F) with secondary phase delta (δ) ferrite. The delta ferrite is responsible for the precipitation of sigma (σ) phase which reduces ductility and enhances hardness as reported by Gray et al. [34]. Thus, toughness may be reduced due to the presence of sigma (σ) phase [9, 10, 40, 41]. **Fig.2 (c**) and **(d)** show presence of austenite in white ferrite matrix



(a) At V= 28V, I= 145A, HI= 0.36kJ/mm, Exp. No.1

(b) At V= 28V, I= 145A, HI= 0.38kJ/mm, Exp. No.2

(c) At V= 28 V, I= 145A, HI= 0.42kJ/mm, Exp. No.

(d) At V= 26V, I= 145A, HI= 0.45kJ/mm, Exp. No.4

**Fig. 2 : Microstructure of duplex stainless steel cladding**

**Table 6 : Observation of corrosion rate of the cladding**

| Sl. No. | Heat input, HI (kJ/mm) | Corrosion rate, C (gm/(m²hr)) |
|---|---|---|
| 1 | 0.36 | 0.458 |
| 2 | 0.38 | 0.282 |
| 3 | 0.42 | 0.353 |
| 4 | 0.45 | 0.499 |

Experimental run 2 gives lower corrosion rate than the other runs **(Table 6)**. **Fig. 3(a-d)** and **Fig. 3(e)** show micrographs of corrosion pits formed as a result of the corrosion test on clad portion and unclad specimens respectively. The intensive, large corrosion pits are clearly observed **(Fig. 3(e))** on bare, unclad plates showing the extent of corrosion taking place in the base plate under corrosive environment. Substantial reduction in corrosion pits is seen on duplex stainless steel clad specimens **(Fig. 3(a-d))** compared to that on the unclad specimens. This is likely due to the presence of corrosion resistant alloying elements in the clad portion, and the presence of dual phases on stainless steel existed in the cladding.

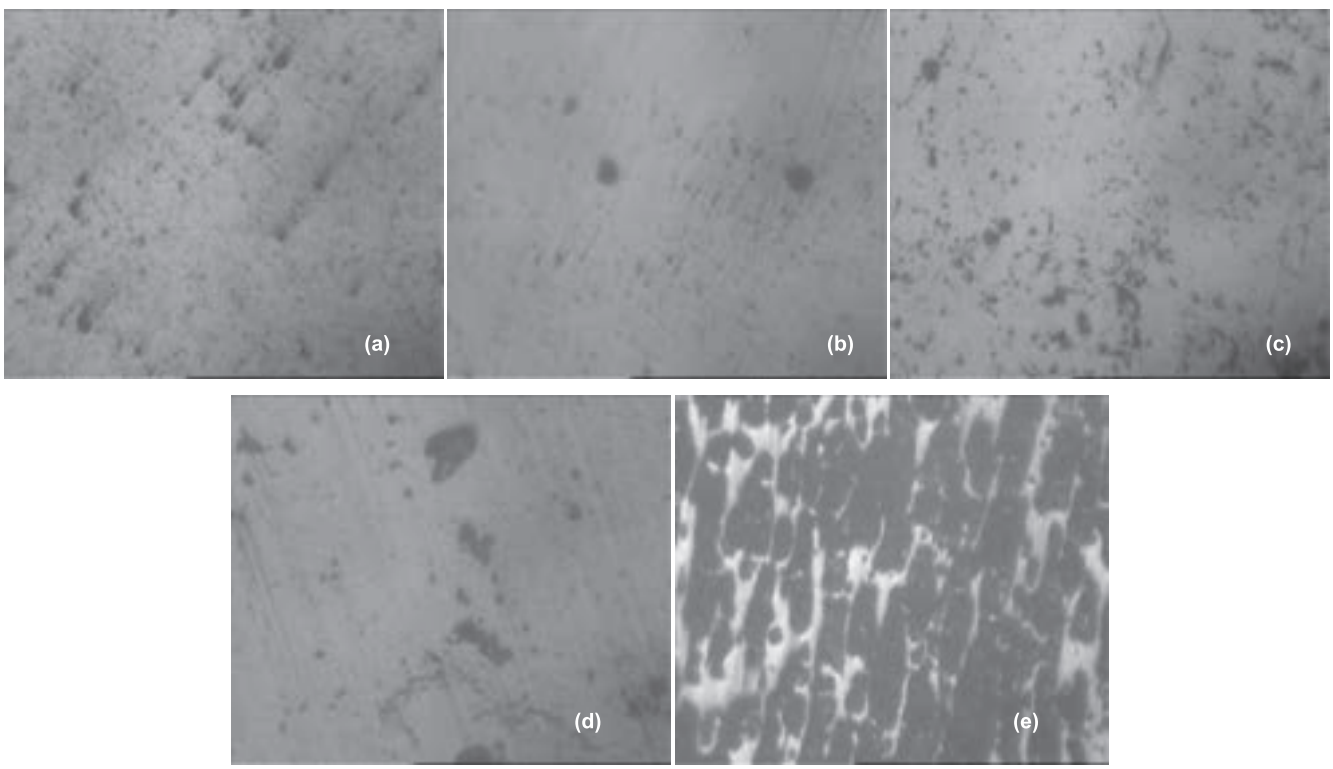



**Fig. 3 : Micrographs depicting corrosion pits (200 X) [(a-d): corrosion on clad surface at experimental runs 1-4, and (e): corrosion on unclad specimen]**

Among the four samples, the sample corresponding to experiment run 2, gives quite low corrosion rate compared to the other test samples as seen in Table 6. Nature of corrosion on this specimen is shown in **Fig. 3(b)**. This corresponds to a moderate heat input of 0.38 kJ/mm. At the heat input of lower and higher values than this, corrosion rate is observed to be higher. At 0.45 kJ/mm heat input, quite a high corrosion rate (0.499 (gm/m²hr)) is observed. Overheating due to high heat input may have resulted in this low corrosion resistance than that at somewhat low heat input. Again, at a quite low heat input, there may be insufficient heating leading not to have favourable duplex phases of austenite and ferrite in the clad portion. Favourable microstructure as seen in **Fig. 2(b)** supports this. At higher heat inputs corresponding to samples as shown in **Fig. 2(c, d)**, predominant austenite phases are observed with low ferrite content thereby suppressing the favourable effects of duplex stainless steel.

## 4.0 Conclusion

Following inference can be drawn on the basis of the present experimental investigation on corrosion of duplex stainless steel clad on low carbon steel specimens using flux cored arc welding:

With 0.38 kJ/mm heat input, microstructure of clad surface shows presence of ferrite to a large extent. Correspondingly, quite a less rate of corrosion occurs. Therefore, this condition with 145A weld current, 28V weld voltage and 516 mm/min torch travel speed may be recommended to adopt in practice in similar situations.

## Acknowledgement:

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# Fabrication of India's Largest, Welded Titanium Vessel

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## Abstract

In this article, the brief about the process of fabrication of India's largest, welded Titanium Vessel is narrated. The challenge faced to make this large capacity vessel and different ways adopted to overcome them are briefed in this article.

**Keywords:** Welding; fabrication; titanium vessel; largest Ti vessel; made in India.

## 1.0 INTRODUCTION

This technical paper deals with Welding of heavy walled Titanium Plates. Thickness as high as 100mm thk which involve multiple pass TIG Welding. Yes, TIG / GTA Welding with No other feasible Butt joint Welding process options being Titanium. Challenges faced during forming of 9m Diameter Dished head, Toricone, Site Installation and Welding criticality for handling such a large sized reactive metal and Welding at Site conditions

Welding Multi-layers, True multi layers in terms of GTAW of 100 mm thickness. Effect of properties like Weldmetal hardness and bend ductility studied in this paper

GR Engineering has past experience of handling large vessels, Manufacturing Workshop and Cranes to handle Large diameter jobs in-house & at Site Conditions, Now handling Critical metal like Titanium Alloy has added a feather in manufacturing capabilities

Executing such a large magnitude Exotic Metal need enormous planning and Pre-manufacturing Preparation, foreseeing hurdles and taking appropriate actions to overcome them.

## 2.0 BASE MATERIAL & WELDING CONSUMABLE DETAILS

| Grade | UTS (N/mm$^2$) | YS (N/mm$^2$) | % Elongation | ASME P-No. | Filler Wire |
|---|---|---|---|---|---|
| **SB265 Gr-2** | 345 (min) | 275 - 450 | 20 (min) | 51 | **ER Ti-2** |

| Grade | Ti | C | Al | V | Fe | $O_2$ | $N_2$ | $H_2$ | Si | Zr | Residual |
|---|---|---|---|---|---|---|---|---|---|---|---|
| SB265 Gr-2 | Bal | 0.08 | -- | -- | 0.30 | 0.25 | 0.03 | 0.015 | --- | --- | 0.1 / 0.4 |
| ER Ti-2 | 99.6 | 0.03 | -- | -- | 0.12 | 0.08-0.16 | 0.015 | 0.008 | --- | --- | ----- |

## WELD THICKNESS INVOLVED

| | | | |
|---|---|---|---|
| Shell Butt Joint | 42, 38, 34 &28 mm | Toricone Butt Joint | 55& 46 mm |
| Base Ring Plate | 100 mm | Dishend End | 36 mm |
| Compression Ring | 65 mm | Skirt Butt Joint | 50 mm |
| Nozzle Butt Joint | 16 mm | | |

Titanium Welding is the Art of Shielding than the Science of Welding. Recent years has seen many developments in following area which made Titanium welding, A easier task

- Improvement in Digital Welding Power sources
- Precision in Controls Instruments
- Availability of Good Quality Shielding gases, Gas Monitors
- Availability of Custom-made Trailing Shields

## 3.0 WELDING QUALIFICATION

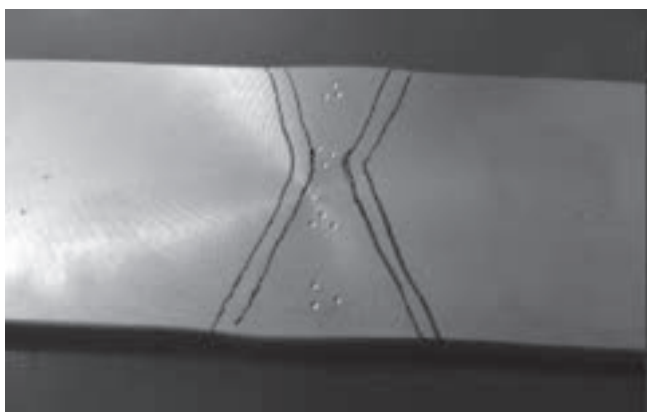
While qualifying the procedure, Apart from meeting the Code and Specification requirements, we have following consideration / Focus area

1. Simulation of Qualification premises and Site conditions
2. Distortion Control measure / Sequencing
3. Use of Similar Trailing shields for Qualification and on job use

Procedure Qualification conducted for Manual GTAW Process as well as Machine-GTAW Process. Wire spools of Titanium wire (dia 1.2mm, 1.6mm) ordered and using special shielding and Trailing arrangement Welding process is automated. Special focus is given on effectiveness of Trailing shield while welding is carried out in Weave mode

Bend & Hardness Test photographs of PQR Test Coupon

**Ben Test Photo**



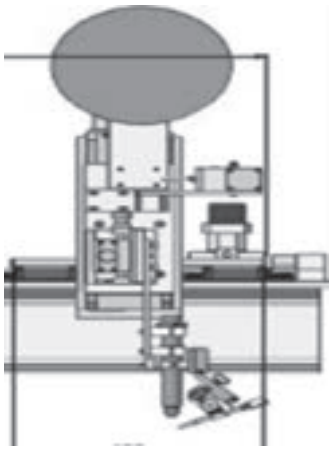
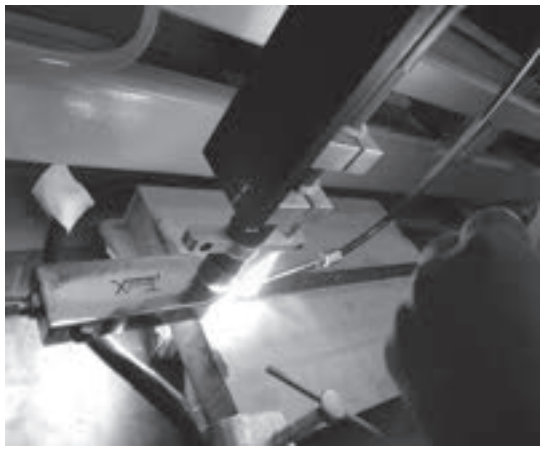
**Hardness, HV10 (Weld Cross Section) Photo**

## 4.0 WELD AUTOMATION

Total welding consumables deposition for the entire Vessel is **4150 Kgs**. To achieve consistency and improve efficiency, Weld Automation is unavoidable. GTAW-Machine process is used. Custom made machine is used for carrying out welding of 100 mm thk Plate. Length of the Weld seam is 8500 mm. Welding machine has Up/Down Slope, Gas Pre-Post Flow, Pulsing, Weave, Dwell time control, seam tracking,

Proper sequencing of weld bead, turning of the plate to produce balance welds made it possible to weld 100 mm thk plate within 6 mm flatness after welding. Radiography is passed is first attempt

Length of Radiographic Testing carried out in Total job is **561 Meters with Zero/Nil repair.**

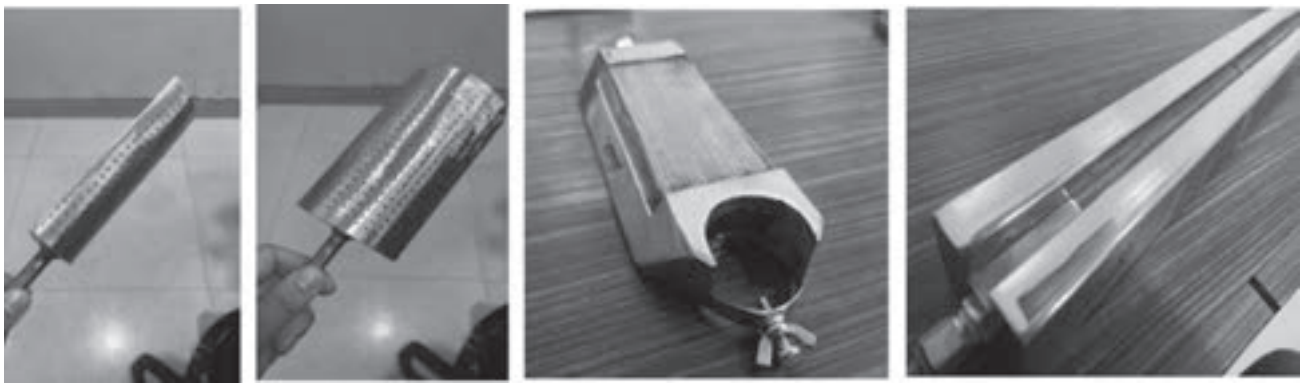
| Concept | Actual | Welding using Trailing Shield, Weave mode |
|---|---|---|
|  |  |  |

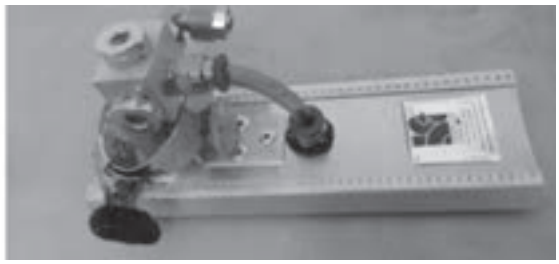
## 5.0 TRAILING SHIELDS / PURGING PADS USED

Trailing shields plays very important role to Protect the weld metal from Atmospheric Oxygen attack when the Weld is hot.. Apart from standard Plate and Pipe type trailing shields, For Corner Weld and for Junction area, different type of customized trailing shields were prepared.

Looking at the High cost of Imported Trailing shields, Local party developed for Customized trailing shields and Purging Pad preparation. Total 14 types trailing shields and Purging pads used in the project

Each trailing shield will undergo check for Weld Decolouration on similar joint configuration and then only it is issued to Shop for manufacturing. QC Inspector have made plan to check the physical condition of trailing shields and Usability at regular interval and certifying it as "Fit for use".



## 6.0 WELD EDGE PREPARATION

Preparation of Weld edge is important activity. There shall be minimal heat input during weld preparation / No decolouration. Thickness of the plates were 38 mm, 42 mm, 50mm, 65mm, 100 mm. WEP machines used as shown in picture below. Surface finish is checked after each preparation. First WEP prepared on sides of the plates and then rolling is carried out.

When use of WEP machine is not possible, waterjet cutting machine is being used. VTL also used in some cases.

Shell were rolled using In-house Rolling mill available inside the workshop

Cone Petals were formed using In-house Press of 1000 ton available inside the workshop

## 7.0 LOCAL ENCLOSURE TO MAINTAIN MICRO-CLIMATIC CONTROLLED CONDITIONS FOR WELDING

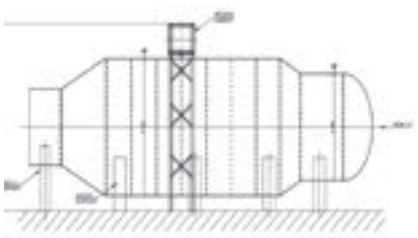
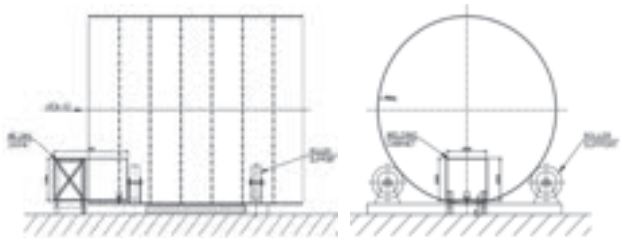
Looking at the size of the job (Dia 9 m x 29m Height x 192 MT weight) it is obvious that the job will be fabricated at Site and Trailing shields will be used, it will be out of Chamber Welding.

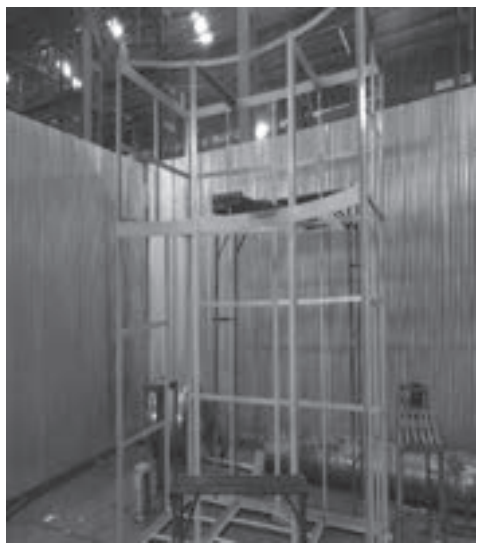
Even after use of best trailing shields, it is important to maintain the cleanliness, humidity in the area of welding. Since welding is carried out in open atmosphere at site, in Rainy time, humidity will be very high. Higher humidity will result in porous welds

Local Welding Enclosures created at the Point of Welding. Enclosures are equipped with

| | | |
|---|---|---|
| Gas Manifold (High Purity Ar) | Flow meter-3x | 3 Nos connection per Welder |
| Air Conditioner | De-humidifier | Electric Heater |
| Oxygen Analyzer | Thermo Hygrometer | Trailing Shields, Purging Pads |
| Acid Cleaning Kit | Welding Machine | Ti Welding Kit |

These enclosures are fitted on the job and the gap between Job and Enclosure is sealed with flexible rubber sheet. Inside area is cleaned thoroughly and checked for cleanliness with "White cloth check"

| Enclosure for Circular Seam Welding | Enclosure for Long Seam Welding |
|---|---|
|  |  |



## 8.0 ROLE OF QUALITY CONTROL

All Preparation, Planning and Welding Qualification ultimately produce the required result on Shop Floor. Production Monitoring and Quality Control Plays very important role in such critical Fabrication.

Inspection stages like "Release of Set-up for Welding" has a added activity of "Readiness for Titanium Welding for a Specific Joint" for this project. Ensuring Welding Parameters are strictly followed, Only Qualified Welders being used, Proper procedures are employed is well followed by experience QA/QC team lead by Mr. P.V. Ghanekar.

Start from Preparation of Stringent Quality Control Plan (QCP) to Stage wise Monitoring and Till the completion of Pneumatic Test, every activity is well organized by Quality Team. The efforts put in for "First Time Right" by QA/QC team resulted in smooth completion of this project

## 9.0 CLEAN ROOM FOR WELDING (MICRO-CLIMATIC CONTROLLED CONDITIONS FOR WELDING)

Manufacturing of Vessel is divided in three area

- Clean Room at GR Pvt Engineering Shop, Tarapur
- Enclosed Shop with 100 Ton Crane. GR Engineering Shop, Tarapur
- Identified area at Site, ABRPL Assam, with Crane of 250 Ton

Choice of location is Depending of the size of the job. Final assembly is done at site.

Welding of small size job is carried out in Clean room. Clean room of size 9mtr X 5mtr X 4mtr is made ready with all necessary equipment's used for welding. Every Equipment, Tools, Accessories, Trailing shield is first Trial Welded/ Tested in clean room and then issued to Shop and Site.

## 10. COMPLETION OF FABRICATION AT SITE

Vessel is installed in Bio Refinery Project, ABRPL, Numaligarh, Assam and Pneumatic Tested successfully completed on 21 Sept 2023.

Authors are thankful to **GR Engineering Private Limited Management (Mr. T B Thakur & Mr. Brajesh Thakur)** for giving us opportunity to work on the Prestigious, Nation's First of a kind project and allowing us to share the technical data and the photographs.

# Welding of 24 mm thick Oxygen Free Copper Plates for Large Size Turbo-generator

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## Abstract

In this article, the process of fabrication of 24mm thick Copper welded and fully machined part of 2500 MW Turbo-generator is discussed. The challenge faced to make Copper Parts for turbo-generator through welding and the ways to overcome them are briefed. discussed. The challenge faced to make this large size turbo-generator through welding and the ways to overcome them are briefed.

**Keywords:** Welding; fabrication; oxygen free copper; turbo-generator.

## 1.0 Introduction

This paper deals with **Oxygen Free Copper** Fabrication for components of Turbogenerator (2500 MW). Oxygen Free Copper has highest electrical conductivity among other Pure Copper grades.

Large section **(24mm thk plates, Dia 3200 mm)** of CopperGrade SB 152 UNS C10200 is welded using GTAW Process. Project Involve Fabrication of **11 Tons of Copper** which has Waterjet Cutting, WEP, Welding, Radiography, Forming, Finish Machining and Trial assembly.

Total 16 Nos Welded, machined round disc of 20 mm thick were manufactured from Plate segments.

This paper focuses on challenges faced during Welding, Preparation of Fixtures, Distortion Control techniques used during execution of the project.

Enormous planning is involved in Pre-heating arrangement, Distortion Control Fixtures, Safety Precautions to be taken to work at temperature as high as 350°C, Selection of Welding Wire with maximum electrical conductivity, Optimal use of Helium Gas and Extensive training of Welders to produce first time Radiographic Acceptable Quality Welds.

Being fully machined component, Distortion control is directly proportional to savings in cost of raw material. Small addition of allowance for machining has huge effect on Cost of Raw material. Optimal balance between maximum distortion possible and minimum allowance to be provided for machining is important.

Machining of Welded disc involve multiple holes drilling, which need to be matched within 0.2 mm tolerance. Various fixture prepared for machining as well as lifting to avoid damage / scoring marks etc. Machining work carried out with outmost precision by 100 points check on job, correction of local high / low point before start of machining. Intermediate checks being added during machining operation to achieve final machined thickness without un-machined patch.

When It comes to Welding of Copper and its being use as electric part, very little data is available on "Effect of Change in Volume resistivity on Welded Pure Copper". Trials conducted to check effect of volume resistivity on Welded component is also illustrated in this paper.

## 2.0 Base Material & Welding Consumable Details

| Grade | UTS ($N/mm^2$) | Type | Conductivity % IACS | Supplied Condition | ASME P-No. | Filler Wire |
|---|---|---|---|---|---|---|
| Cu-OF (CW008A)/ SB 152 : C 10200 | 205 (min) | O2 : 0.0010 Cu : 99.95% | 100 | Annealed | 31 | CuSn-1 |

## 3.0 Selection of Welding Process

Welding Process considered G : Good for Oxygen Free Copper are GTAW, GMAW and EBW.

Since our job is large in diameter (more than 3000 mm), Large size Vaccum Chamber is not available and hence the Possibility of EBW (Electron Beam Welding) is ruled out.

We need to Select a Process between GMAW and GTAW.

Since thickness involved is 20 mm plus, there is possibility of fast heat dissipation which can cause LF in Welding. Being Weld joint has RT of All butt joints, GTAW Process is selected for Final Welding of the job.

Following table (from AWS Handbook) may be referred for Suitability of Welding Process for Oxygen Free Copper Grade

| Applicable Joining Processes for Copper and Copper Alloys | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Alloys | UNS No. | Oxygel Gas Welding | SMAW | GMAW | GTAW | Resistance Welding | Solid-State Welding | Brazing | Soldering | Electron Beam Welding |
| ETP Copper | C11000-C11900 | NR | NR | F | F | NR | G | 3 | G | NR |
| Oxygen-Free Copper | C102000 | F | NR | G | G | NR | E | E | E | G |
| Deoxidized Copper | C12000 C123000 | G | NR | E | E | NR | E | E | E | G |

## 4.0 Selection of Weld Consumables

As per the literature, ERCu copper is recommended for GTAW of cooper. Theses electrodes have the highest conductivity of any copper electrode but contain minor alloying elements to improve weldability.

Usually De-oxidised Pure copper is used for manufacturing welding wires. Many of the wire manufacturer gives the welding wire for welding Base metal as Oxygen Free Copper.

| Sr | Specification | Class | Grade |
|---|---|---|---|
| 1 | AWS | A5.7 | ERCu |
| 2 | BS EN | EN 14640 | S Cu 1898 / CuSn1 |
| 3 | BS | BS 2901 pt 3 | C7 |
| 4 | DIN 1733 | DIN 1733 | SG-CuSn (2.1006) |

**Chemical Composition of the Welding Wire used on job**

| Weld Wire Class | Cu | Sn | Mn | Si | P | Al | Pb | Fe | Ni | A/C | A/T |
|---|---|---|---|---|---|---|---|---|---|---|---|
| ER Cu: AWS 5.7 & CuSn1: 1898 | Bal | 0.83 | 0.21 | 0.20 | 0.012 | <0.001 | <0.001 | 0.001 | <0.001 | <0.05 | <0.1 |

**Base Metal Electrical conductivity (as per AWS Welding Handbook, Table 3.8)**

| Sr | Deposited metal conductivity | Electrical Conductivity % IACS |
|---|---|---|
| 1 | Oxygen Free Copper | 95 - 101 |
| 2 | Phosphorous De-oxidised Copper | 83 |
| 3 | Phosphor Bronze | 37 |
| 4 | Silicon Bronze | 26 |
| 5 | Beryllium Copper | 22 |

From the table, its clear that, Base Metal, Oxygen Free Copper has highest Electrical Conductivity

## 5.0 Test Specimen Preparation to Check Electrical Conductivity

### Method of measurement of Electrical conductivity and volume Resistivity of copper

The electrical conductivity was measured using a small-signal 4-wire Ohm meter (RS Pro RM-805) and via large-signal 4-wire measurement method in the range from 10A to 60A DC (Fluke Norma 4000) in accordance with ASTM B193-16.

The electrical resistivity was measured in two methods having small and big resistance to test the range of conductivity of the additively manufactured samples. The ends of the samples were manually polished to ensure maximum and uniform contact with the testing probes. From the resistance measurements, the conductivity of the samples was calculated. This measurement is mainly influenced by the surface roughness and density of the sample. Materials 2022, 15, 7563 6 of 19 The presence of peaks and valleys can disrupt the contact area with the testing probes and pores, and any unfused powders are a clear obstruction to the conduction of electricity.

### Method followed by us for Specimen Preparation

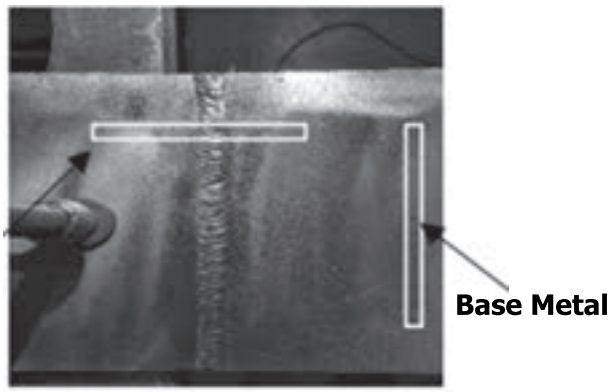
Welding carried out on Single Vee Grooved Test plate having thickness 12 mm. After Completion of Welding, Dye Penetrant Test and Radiography Test were carried out to ensure sound Weld.

Two Nos Round Specimens Prepared. One from Base Metal and Other with Weld Joint at the Centre of the Weld as per the location shown in below photographs (Location shown in Yellow box). Both the specimens were machined to 10 mm diameter bar so that Comparative results were obtained.

**Sample Weld Sample Base Metal Test Values Observed:**

**Report**

**Welded Test Coupon**




Results : Base Metal : 95.93 % IACS

**Prepared Test Specimens**

Transverse, Weld Metal : 83.88 % IACS

Drop in Conductivity : 12.6% after Welding (Using Welding wire CuSn-1)

(Conductivity measured at @ 20.8ºC, M/s ELCA Report no R-2764)

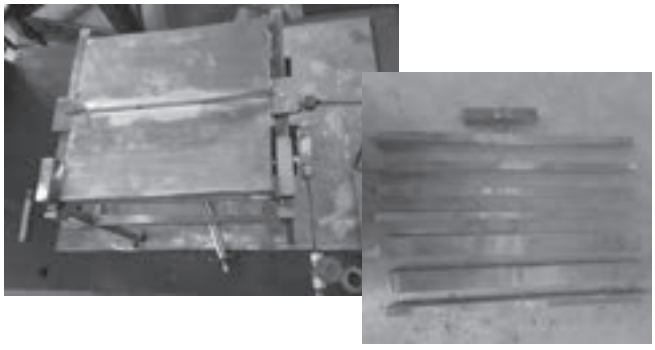
Drop in Conductivity : 19.8% after Welding (Using Commercially Pure Copper wire)

## 6.0 Welding Qualification & NDT

Welding Qualification is conducted as per ISO 15609-1. Welder Test as per 9606-3

Preheating of 350ºC is applied before welding. Shielding gas used is 99.995% Pure Helium.

Process 141 (TIG) is used. Qualification is conducted on 14 mm thk and 24mm thk Plate.



Test Coupon during Welding Test Specimen Preparation

All butt and Fillet welders undergone Dye Penetrant Test and Butt Joints are Radiographically Tested. Ultrasonic Testing also carried out for Butt joint.

## 7.0 Preheating

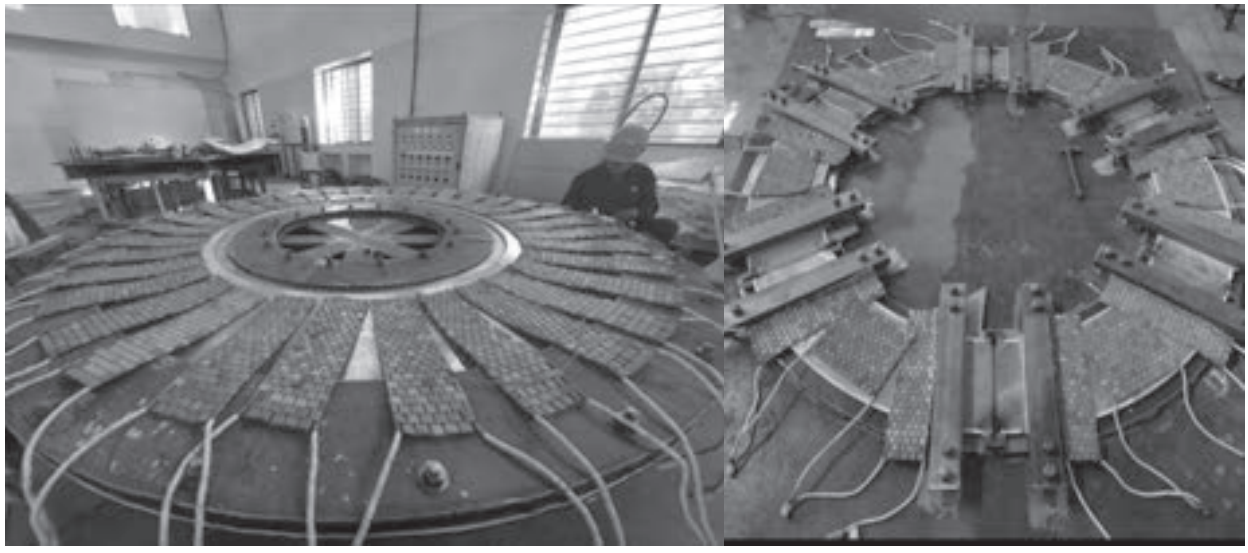
High thermal conductivity of Copper results in the rapid conduction of heat from the weld joint into the surrounding base metal. This makes achieving fusion and weld penetration difficult.

Out Base metal thickness in 24 mm and the diameter of the plate to be welded is more than 3000 mm. Heat dissipation is very fast. Verly slow and Uniform heating method is applied. Electric Resistance heating (multiple coils) used to ensure uniformity in heating. At the time of tack weld also, we need to preheat for long time.

Placement of Heating coils at set-up stage and after root pass welding is different. At set-up stage, being base metal is not connected, heat do not pass to adjacent metal. Whereas after root run welding, Base metal is connected and heat passes through it.

Expansion of base metal shall be considered during preheating. For example, dia of around 2500 mm, for Preheating to 300 degree C, the expansion will be as high as 5 mm (OD will increase by 7-8 mm).

In this case, authors have issued Pre-heating plan for each component to shop floor, so that Placement of Coil, No. of Coils to be placed, wrapping area etc. is clear.

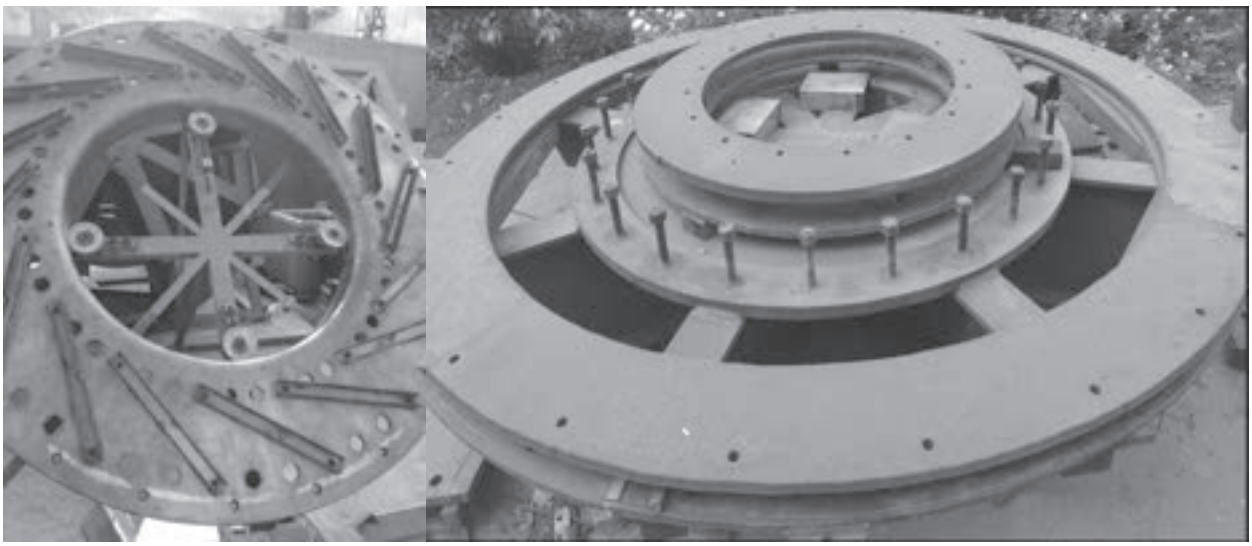


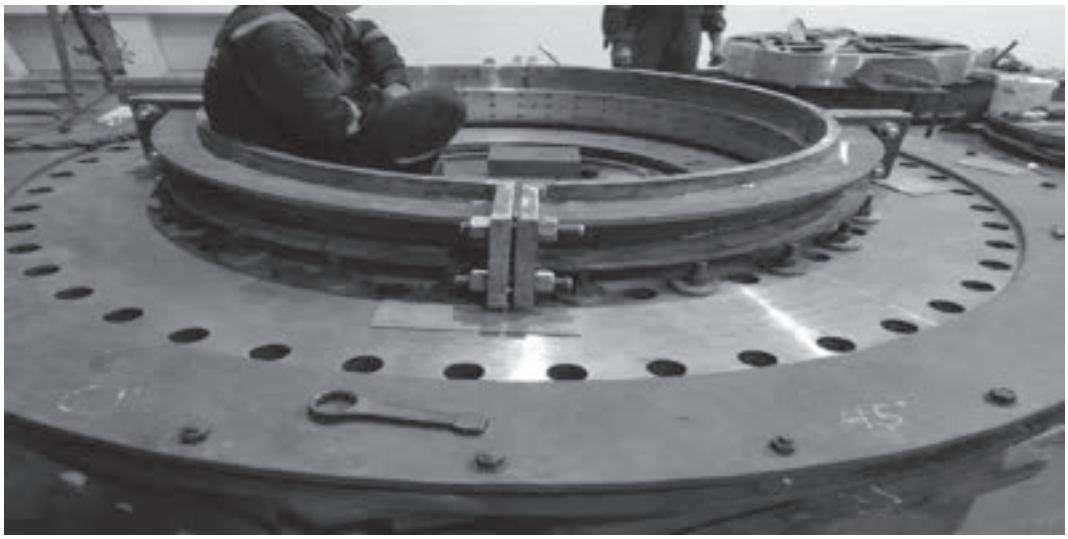
## 8.0 Fixturing

Thermal Coefficient of Copper is 1.5 times that of the steel, so its obvious that the distortion will be greater with copper alloys. Fixturing and Welding procedure must be designed to limit the restraint of Copper alloys that are likely to hot crack when highly restrained.

While using steel fixtures for Clamping the job, care shall be taken to avoid Steel embossing marks on the copper parts. Advised to add a Soft metal like aluminium or copper in between the fixture and the job. Clamping shall be done considering expansion of the job during heating. Sufficient allowance shall be provided for thermal expansion of the job. When clamped in heated condition and welding is started, don't miss to loosed the clamps on cooling. So that job is allowed to returned to its original position after it cool down and shrink.

4 Nos. of full size, machined fixtures have been prepared for execution of the job. OD rings were provided to avoid edges from warpping and weaviness formation.





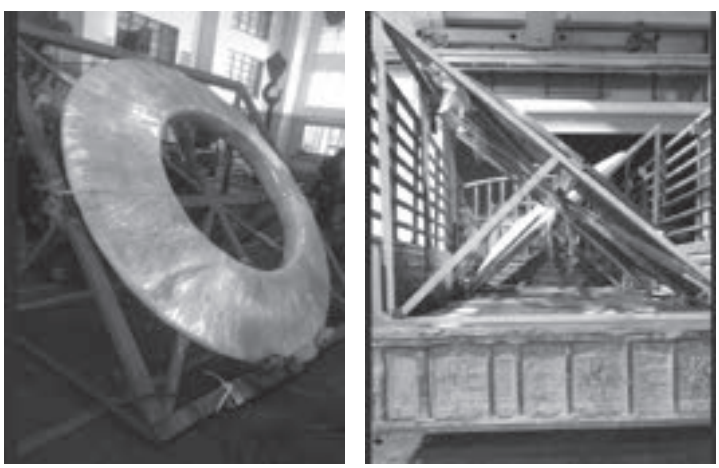
## 9.0 Forming

4 Nos. of Discs are undergone Forming Operation. Hot forming is carried out. There is no past experience available in Indian market for such a large diameter Copper plates forming. Precision's Design and Engineering Team conceptualized the Die and Punch design. Die and Punch are fabricated in-house. 500 Ton press used for firming

## 10.0 Transportation Fixture and Packing

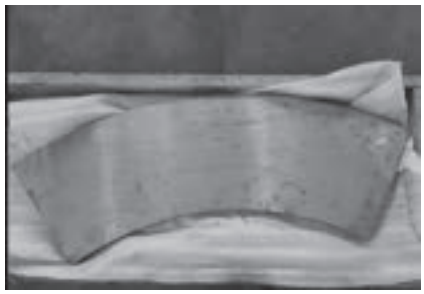
Copper being soft, shall be properly handled during Transportation. Looking at the diameter of the job, it's a OD Consignment. Fixture is prepared in such a way that the Ring is Transported inclined.

Fixture for Transportation has Lifting hooks and Clamps provided to avoid moving of the ring during transportation



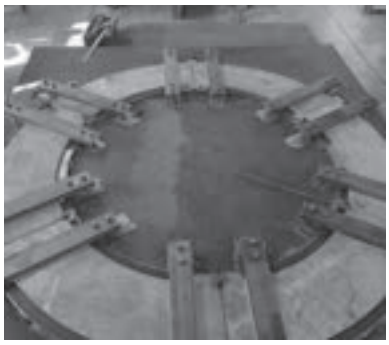
## 11.0 Steps in Manufacturing

WaterJet Cutting

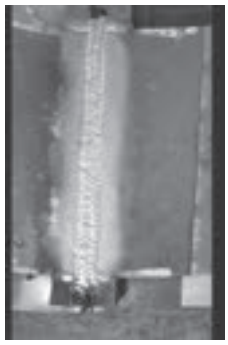


Profile Cut Segment

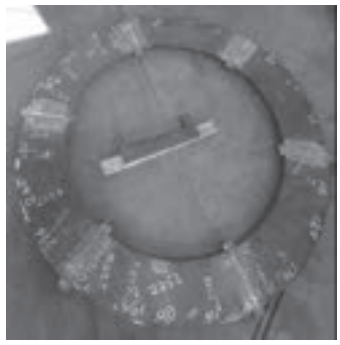
Electrical Preheating

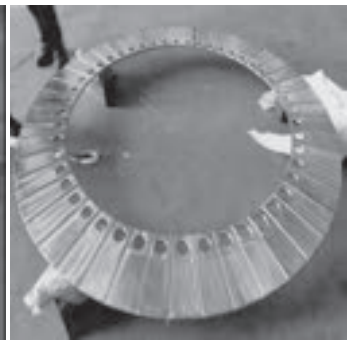


Welding using Fixtures



After Weld Completion





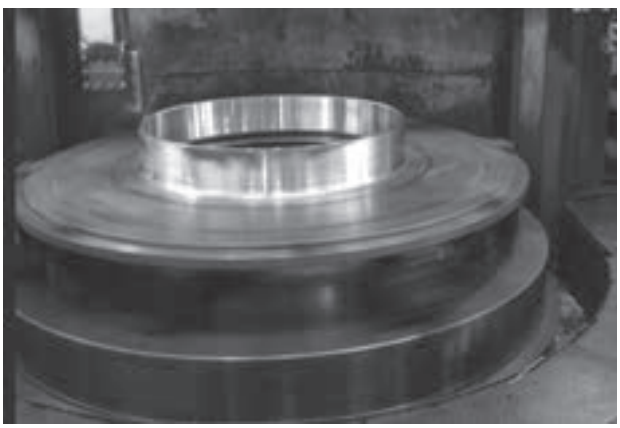
After Machining

## 12.0 Machining

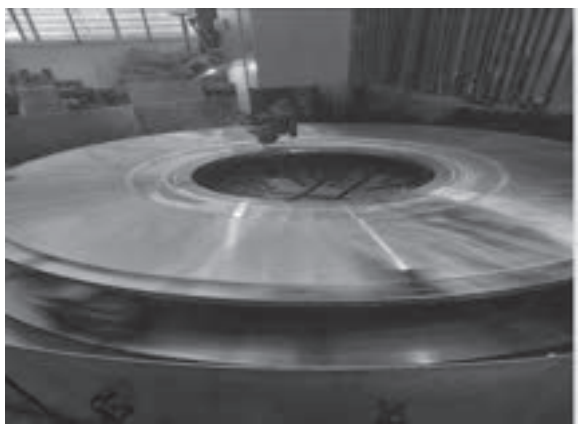
All the Welded Rings were to undergo machining. Each ring has more than 100 Holes drilled in it and the rings are assembled in stack. Holes in stack shall be matched. 3 Nos. of fixtures (fabricated and machined) used for machining Operation.

Holes are drilled using a special tool and tolerance achieving is within 0.2 mm.

Flatness of the ring after machining achieved within 0.5 mm.



Machining on VTL



Facing done on VTL

## 13.0 Conclusion

Heavy Walled thickness Copper Plates of 24 mm thickness can be fabricated (Cutting, Forming, Welding and Machining) with relative ease and Radiographically acceptable welds are possible. Heating arrangement, Plan is crucial at planning stage. Special Precaution to be taken while handling and transportation being soft metal. Even though Hellium is depleting rare gas, for thickness more than 20mm, authors could not find any other suitable option for Welding.

There is Drop in Electrical Conductivity after Welding. Welds made using CuSn-1 wire shows Drop of 12.6%. When welded with Commercially Pure wire, Drop Observed in 19.8%. Since there is no significant literature available on "Drop in electrical conductivity of Copper after welding", more experimental study is needed.

## Acknowledgement :

Authors are thankful to Precision Gasification Services Pvt. Ltd. management (Mr. Sanjay Padwal & Mr. Sonam Tilva) for giving us opportunity to work on the Prestigious, Nation's First of a kind project and allowing us to share this technical data.

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5) Greenfield P; A review of the properties of 9-12 % Cr steels for use as HP/IP rotors in advanced steam turbines. Edited by J. B. Marriott, K. Pithan, Commission of the European Communities.

6) Pulsed MIG Welding of Naval Brass, Presented at National Welding Meet 2017, organized by IIW, at Bengaluru, India

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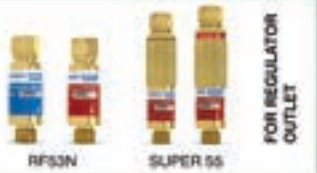


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# AWS Celebrates Its 105th Anniversary


**In honor of this milestone, read about the Society's early days and view a timeline of accomplishments**

BY KRISTIN CAMPBELL

It seems just like yesterday we were in the year 2019 celebrating AWS's 100th anniversary. The *Welding Journal* covered the milestone through unique columns filled with stories honoring our rich history. Now, it's already 2024, and we're marking our 105th anniversary. Below is meaningful text provided by August F. Manz, an AWS Fellow and honorary historian.

## *100 Years Ago, AWS Was Five Years Old*

In 1924, two Sections were added to AWS: the Western New York Section and the Kansas City Section. With the addition of these two new Sections, AWS membership grew to 718 members by midyear. In February, discussions began on the formation of a Detroit Section, which was added in 1925. This year, AWS membership reached more than 62,000.

In addition, the 5th Annual Meeting of AWS was held in New York City during April 23–26, 1924.

In 1924, welding was at its infancy. There was no gas tungsten arc welding, gas metal arc welding, submerged arc welding, or plasma arc welding, to name a few.

The year 1924 was noteworthy for welding because of the following:

- *The* Welding Journal *published 62 papers/reports*
- *Lloyd's Register of Shipping issued arc welding regulations for ship construction*
- *Welded leak-proof aluminum fuel tanks made it possible for four Army Air Service airplanes to circle the globe*
- *In England, Dr. Pulling reported recent x-ray developments made it possible to see through 4 in. of steel and discover the smallest of flaws*
- *An all-welded natural gas pipeline, 14 miles long, was built using acetylene welding*

***Today, AWS has become a world class organization. Visit aws.org to learn more.***

Works Consulted: "Through the Years with the AWS – A Definitive History of the American Welding Society," a manuscript by T. P. Schoonmaker, 1990–1991 AWS Technical Papers editor emeritus.

**On the following pages, there's a timeline highlighting a wide range of AWS accomplishments over the last five years.**

# Timeline of AWS Accomplishments from 2020 to 2024

The AWS Board of Directors announced Gary Konarska II as the organization's executive director and chief executive officer, succeeding Ray Shook, who held the position for 15 years.

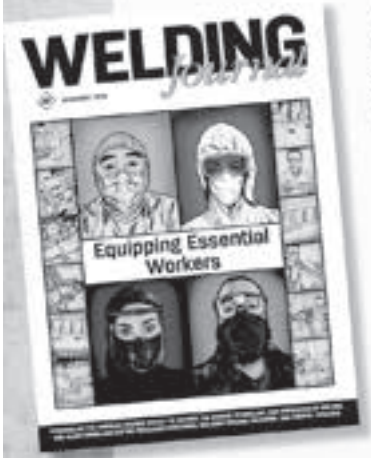
At the AWS Education 2020 Virtual Summit, both the educational sessions and professional programs were live and interactive, packed with fresh research, insights, best practices, and more. It attracted 489 registrants.

Standards committees began using an online balloting system to review, comment, and approve new, revised, or reaffirmed standards.

## 2020

*The Welding Journal* reported on talents getting used for good amid the COVID-19 pandemic and recognized the extraordinary efforts by many to make masks, respirators, face shields, and more.

AWS released D1.1/D1.1M:2020, *Structural Welding Code — Steel*, and A3.0M/A3.0:2020, *Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting, and Thermal Spraying*.




The AWS Foundation launched *weldingworkforcedata.com* to highlight the need for welding professionals.

All standards committee meetings were conducted via teleconference or hybrid, allowing participants to attend meetings without the necessity of travel.

## 2021

The AWS ARCademy video series, available on *youtube.com/@videoaws*, was launched to provide resources for those interested in educating themselves toward a welding career.

AWS began using AWS D1.1/D1.1M:2020, *Structural Welding Code — Steel*, exclusively in Certified Welding Inspector (CWI) exams, and the Society began offering a comprehensive two-week CWI preparation option.

FABTECH returned to an in-person event and became the first large-scale B2B and manufacturing trade show to be held at Chicago's McCormick Place since the onset of the COVID-19 pandemic.


The *Welding Journal* celebrated its 100th anniversary and published a special column throughout the year in honor of this major milestone. It also debuted a redesigned layout with new type fonts, color palettes, and article templates.

Twenty agents from across the globe assembled at AWS World Headquarters in Miami, Fla., for the International Agents Meeting. Representing 13 companies, the agents in attendance hailed from nine countries.

AWS introduced the Lean Management for Welding Productivity online course, which aims to identify and mitigate waste to help businesses suit their production to demand.


*Inspection Trends* began being published as part of the *Welding Journal*, a pairing that gives all AWS members access and exposure to more welding inspection content.

The Taiwan International Section of AWS (AWS-Taiwan) hosted a Certified Welding Inspector (CWI) conference to share hands-on experiences and to address the significant roles of the AWS CWIs and Certified Welders in the fast-growing offshore wind farm industry in Taiwan.

In January, ESAB kicked off its Future Fabricators Program with the announcement of 12 scholarships in the amount of $5000 each that are awarded through the AWS Foundation.

In February, the annual AWS Transition Ceremony took place. AWS President Michael A. Krupnicki was welcomed, and he spoke about his long-time experience in the welding industry along with strengthening our board governance, enhancing the volunteer experience, and more matters.

## 2022

The AWS Foundation awarded more than $2 million in scholarships.


The AWS Foundation started weldingapprenticeship.com, an employer-focused resource for Registered Apprenticeship Programs.

## 2023

The AWS Board of Directors selected Robert "Bob" W. Roth as the interim executive director and CEO. The appointment came as outgoing Executive Director and CEO Gary Konarska II transitioned into a new role at The Lincoln Electric Co.


AWS launched its free Student Membership for up to four years for all students engaged in a form of industry-related education or training. More than 6000 students took advantage and became members of the Society within the first six months.

The AWS redesigned website debuted at aws.org, offering a responsive design optimized for tablets and mobile devices, a live chat feature, and more.


## 2024

**The rest of this year is all ours to achieve many more accomplishments!** WJ

**KRISTIN CAMPBELL** (kcampbell@aws.org) is managing editor of the *Welding Journal*.

# National Welding Month SHINES BRIGHT


Danea Buschkoetter enjoys teaching welding students at Cloud County Community College, Concordia, Kans.

BY KRISTIN CAMPBELL

## AWS ARC Stars share what this month means to them

The AWS ARC Stars — Jason Becker (*@arcjunkiespodcast* on Instagram, and the handles that follow are also found on this platform), Danea Buschkoetter (*@welder_danea*), Sean Flottmann (*@dabswellington*), Stephanie Hoffman (*@_stephanie_hoffman_*), Rachel Lee (*@thetinywelder*), and Chloë Hudson (*@arcweldingangel*) — are really looking forward to National Welding Month 2024. AWS recently established this year's theme as "Increase Your Impact" (more about that is located in the story's end section), and the ARC Stars share their thoughts on their impact and more in the following Q&A.

### 1. What does National Welding Month mean to you?

**Becker:** National Welding Month carries a deep significance for me as a welder who has spent the past ten years teaching our craft. It represents my passion for the art of welding and my commitment to passing down knowledge to the next generation of welders.

**Buschkoetter:** It is a time I can use to recruit the next generation of welders to help the shortage that we are currently facing across the world. During the month, I challenge myself to post every single day with something welding related. Oftentimes this brings new eyes to the content I produce and hopefully inspires other individuals, especially women, into this industry. The month gives us a time to celebrate how great the industry truly is, learn more about welding and trade skills, share cool projects, and shout out to other welders excelling in our industry. The welding industry is truly the backbone of our world.

**Flottmann:** National Welding Month is an opportunity to shed the spotlight on those hard-working tradesmen and women who most people never even consider — the Ironworkers, millrights, fabricators, oilfield hands, pipeline welders, boilermakers, etc. These are the men and women who keep the lights on and keep us warm. This month is our opportunity to remind people of the dire necessity of skilled tradesmen and tradeswomen.

**Hoffman:** National Welding Month is a time to celebrate and recognize the importance of welding with career perspectives, welder appreciation, and building up our community, allowing life-long welders to aspiring welders to showcase their love for the trade. During this time, I think it's so important that we acknowledge and appreciate the hard work of welders in various sectors, including construction, manufacturing, automotive, aerospace, art, and more. It's a month to celebrate and create a sense of unity and camaraderie among welders and welding enthusiasts.

**Hudson:** I think welding month is an excellent opportunity to really highlight this trade and how everyone is impacted by

those who carry the skills necessary to build the infrastructure that keeps the world running. Every single person is impacted by a welder's ability in their day-to-day life. Roads, buildings, cell towers, the very car you commute in — all these things require tradespeople — especially welders.

**Lee:** To me, National Welding Month means 30 days to celebrate all the incredible opportunities, possibilities, and advances in the welding field.

## 2. How will you celebrate National Welding Month this year?

**Becker:** I plan to celebrate National Welding Month the same way I celebrate every month, by sharing my knowledge, promoting safety, and nurturing a sense of community among welders while contributing to the growth and recognition of our trade.

**Buschkoetter:** I plan again to post every single day of National Welding Month on my social media. In my content, I often share educational-related welding content. I also like to shout out to my women welding friends who are excelling in the industry. My game plan this year is to also prefilm my content, so I am not having to film every single day.

**Flottmann:** The same way I do every week, by fully immersing myself in the obsession that has dictated my career — welding. Whether teaching (I'm currently at the American Welding Academy, Union, Mo.), recruiting, contracting, or welding artwork, my world revolves around this industry.

**Hoffman:** I will celebrate by supporting the trade in new ways as I move into a new role out from under the hood and into the business side of industry (with Miller Electric Mfg. LLC as Northeast customer experience manager), proving that this career is not a one-way street or a dead end. There is growth and opportunity at each step, taking my industry knowledge and passion for welding education to new heights.

**Hudson:** I will celebrate by doing what I do best, welding. I'm lucky enough to call Joe Gibbs Racing in Huntersville, N.C., my employer, and it's been an absolute dream come true of a job.

**Lee:** I'm going to celebrate National Welding Month by sharing tips, tricks, and projects on my Instagram for the entire month of April.

## 3. How has AWS increased your impact?

**Becker:** AWS has significantly increased my impact on the welding community. Through their support, I have been able to further my mission of helping, educating, and inspiring the next generation of welders. AWS has showcased my podcast, *Arc Junkies*, and I also host *Weld Wednesday with AWS*; granted me the role of a moderator at FABTECH, and facilitated my participation in AWS Section 510 meetings (Central Florida-Orlando), all of which have allowed me to reach and connect with a broader audience of aspiring welders.

**Buschkoetter:** As an active member of AWS, my professional journey in the welding industry has experienced a significant uplift. AWS has provided me access to advanced resources, industry-leading certifications, and a community of professionals who share a common passion for welding. Engaging in AWS events, classes, and meetings has not only expanded my knowledge but has also enhanced my skill set. Through networking opportunities facilitated by AWS, I've established connections with industry leaders, enabling me to stay current with the latest advancements in welding technology that I can bring back to my students. The continuous support and resources from AWS have been instrumental in my professional career (instructing welding students at Cloud County Community College, Concordia, Kans.).

**Flottmann:** AWS has increased my impact in many ways. Aside from giving welders a platform to promote the trades and the benefits of certification, AWS has helped many of our students reach their goals through scholarships and training programs. The recent addition of the ARC Stars is just another facet of the promotional team's efforts to help put the spotlight where it belongs — back onto the hard-working men and women of the trades.

Chloe Hudson works at Joe Gibbs Racing, Huntersville, N.C., and likes gas tungsten arc welding.

Rachel Lee performs gas tungsten arc welding to install a job box on the inside of a horse trailer she helped convert into a mobile bar for wedding venues.

**Hoffman:** AWS has increased my impact by allowing me to grow my network and industry knowledge. The Society has also given me the confidence and support I needed to make many of my career goals a reality.

**Hudson:** AWS absolutely impacted the trajectory of my career. I was lucky enough to attend trade school and able to get AWS certifications that made me universally qualified post-graduation. This put me ahead of other welders on jobsites coming in, and it was proof of my proficiency right out of the gate. I'm a life-long student and always looking for ways to add to my proverbial tool box. I just accomplished the monumental task of successfully becoming a Certified Welding Inspector (CWI). With this status, I've made myself far more valuable to my place of employment and [given myself] the opportunity to continue adding to that certification to further myself even more.

**Lee:** To share how AWS has increased the impact I've been able to make, I have to start at the beginning of my welding career to when I was enrolled at Lanier Technical College, Gainesville, Ga., and won my initial membership at a technical meeting hosted by the AWS Atlanta Section. Since that day, I've been able to achieve professional success (operating The Tiny Welder LLC in Georgia, specializing in mobile welding services) in large part due to the network AWS has helped me cultivate via the conferences, seminars, and events such as FABTECH. Getting more involved in my local Section, in turn, helped me increase my impact to a national level.

## Increase Your Impact

Since 1996, the month of April has been designated National Welding Month to raise awareness for the welding industry and its available career paths.

"This year's theme, 'Increase Your Impact,' is a call to continuous improvement and active engagement on individual, corporate, and industry-wide levels," said Cassie Burrell, senior vice president, marketing & membership development, AWS.

**A variety of events planned through the month include:**

- **Take The Torch Membership.** Individuals who become AWS members during National Welding Month will receive 15 months of membership for the price of 12.
- **My Welding Story on Instagram.** Through the month, AWS will highlight stories from those in the welding community and share how welding has shaped their lives. If a welding industry professional would like their welding story to be considered, they can complete the survey at *weld.ng/myweldingstory* for a chance to be featured on AWS's Instagram stories.
- **Special Instagram Live Episode of *Weld Wednesday* Podcast.** Join us for a special Instagram Live event of our *Weld Wednesday* podcast, hosted by Jason Becker, as we delve into the theme of "Increase Your Impact" in celebration of National Welding Month. It will be held on April 3 at 8 PM (EST). The featured guest will be Shanen Aranmór, founder of Weld Like a Girl™, lead CWI/welding judge on Project MFG, and passionate skilled trades advocate. She will share how welding has impacted her life and career and how she has inspired individuals to make a difference in their personal careers, communities, and the industry as a whole.
- **AWS Foundation Swag.** Members who set up a monthly recurring donation of $3 or more at *aws.org/donate* will receive a limited-edition AWS Richardson trucker hat.
- **National Welding Month Discounts.** Through April, AWS will be offering discounts on AWS products and services, including online training, the *Welding Handbook*, and more.

For more information, visit *aws.org/nwm*. WJ

**KRISTIN CAMPBELL** (*kcampbell@aws.org*) is managing editor of the *Welding Journal*.

# 2024 ASME SECTION IX DECODED: A WORKSHOP

ASME Section IX Decoded is a comprehensive three-day workshop that will train the participants to comply with the requirements of ASME Section IX, Welding, Brazing, and Fusing Qualifications. Participants will gain a working knowledge of ASME Section IX. A review of the welding processes and variables and basic steel welding metallurgy will be conducted to provide all participants with sufficient background in welding technology to interpret and understand Section IX. The mechanics of using Section IX and how to address its requirements will be explained in a simple, straightforward manner.

| Three-day Sessions 8AM - 5PM | | | |
|---|---|---|---|
| March 12th - 14th<br>Miami, FL | May 7th - 9th<br>Houston, TX | August 27th - 29th<br>Charlotte, NC | December 3rd - 5th<br>Denver, CO |

**INSTRUCTOR:**

**Walter J. Sperko**, P.E. is President of Sperko Engineering Services, Inc, a consulting firm specializing in metal fabrication technology, including material selection, welding, heat treating, inspection, quality assurance, and failure analysis. Walter has extensive experience in piping and pressure vessel fabrication, installation, maintenance, and repair. He is a past-Chairman of the ASME Welding, Brazing, and Fusing Standards Committee IX and several subgroups. Walter is a registered Professional Engineer in several states, holds six US patents, and is a Fellow of the ASME and a Counselor of the AWS.

Upon completion, attendees will earn **24 PDHs.**

To register, **scan here**

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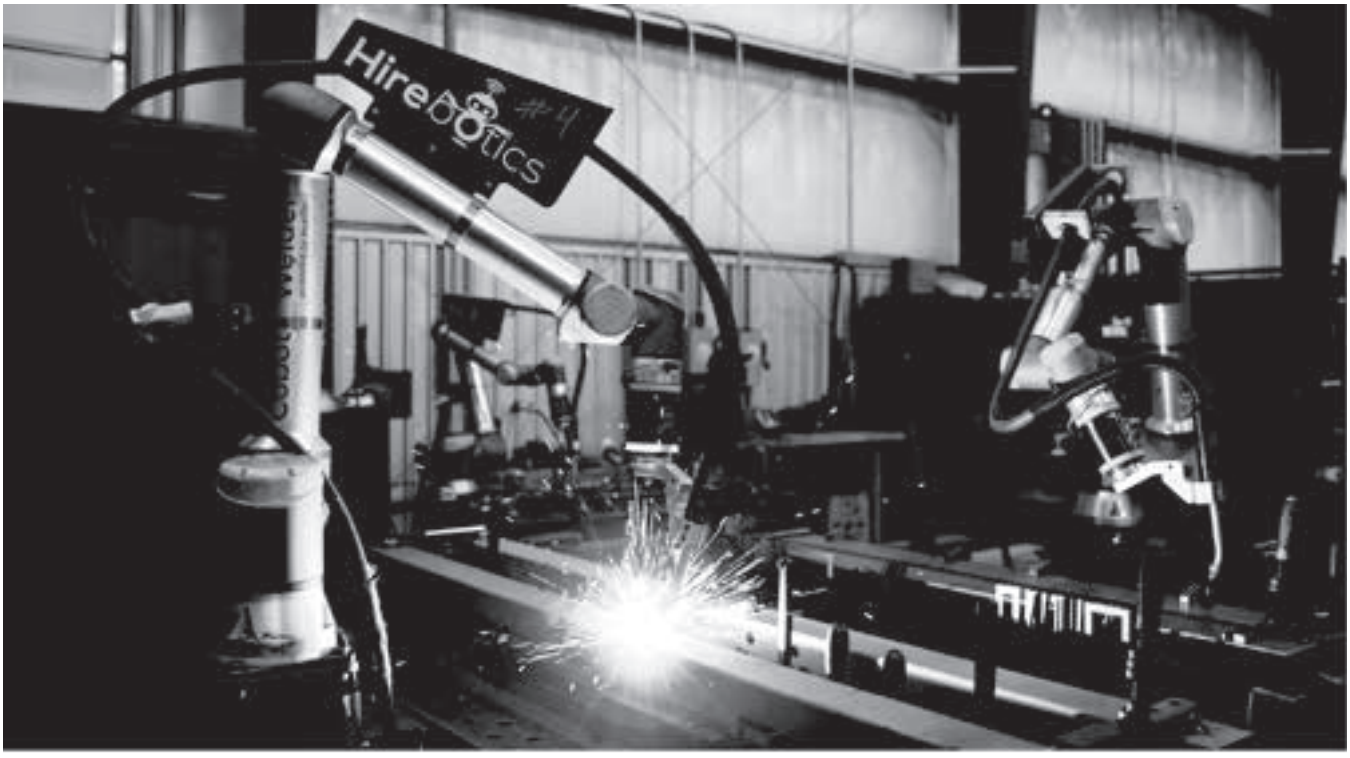
AWS
American Welding Society®
AWS COUNSELOR NOMINATION
The American Welding Society established the honor of Counselor of the Society to recognize members for a career of distinguished leadership contributions in the advancement of welding science and technology. Election as a Counselor is based upon an individual's career of outstanding achievements and accomplishments. The selection committee is seeking qualified individuals who can demonstrate their leadership in the welding industry as evidenced by:
• Sustained service and performance in the advancement of welding science and technology
• Publication of papers, articles and books which enhance knowledge of welding
• Innovative development of welding technology
• Society, National and Section contributions
• Professional recognition
• Leadership in AWS or other corporate levels, particularly as it impacts the advancement of welding technology
• Facilitating others to participate as a volunteer in the advancement of welding technology
For specifics on the nomination requirements, please contact Malisa Mercado at mmercado@aws.org at AWS headquarters in Miami, or simply follow the instructions within the Counselor nomination portal link located at weld.ng/cf. Please remember, we all benefit in the honoring of those who have made major contributions to our chosen profession and livelihood. The deadline for submission is June 1, 2024. The Counselor Committee looks forward to receiving numerous Counselor nominations for 2025 consideration.
Sincerely,
David J. Nangle
Chair, Counselor Committee
Nominations for Counselor of the Society are open.
Submission Deadline June 1, 2024.
Membership | Certification | Education | Training | Standards | Publications | Events | Foundation | Bookstore
aws.org




# Weld Setting Optimization for COLLABORATIVE ROBOTS

BY KYANNE PEEK

There are many videos showcasing how collaborative robots, or cobots as they're commonly known, can weld. What is not always shown and less understood is how to maximize welding efficiency with cobots. Optimizing weld settings when using a cobot can increase productivity and quality and reduce costs.

## Why Weld with a Collaborative Robot?

As industries face a shortage of skilled labor, cobots offer a solution. Cobots can significantly enhance the productivity of the existing workforce.

"The cobot allows you to establish a procedure that is followed precisely over and over again, akin to following a recipe," explained Andy Harris, welding technology supervisor at Wenger Mfg., Sabetha, Kans.

Harris also pointed out the overlooked cost of rework when welding manually vs. cobot welding, stating, "Millions are spent on postweld cleanup [with manual welding]. Cobots can significantly reduce this by ensuring welds are done correctly the first time."

It's no wonder cobots have quickly become a must-have for many manufacturing plants and welding shops.

## Differences between Manual and Cobot Welding

Manual welding is a skill that has been honed over centuries and requires a high level of craftsmanship and experience.

A welder must have a steady hand and an experienced eye to produce consistent welds. However, manual welding can lead to fatigue and distraction, and even the subtlest hand tremors can introduce variability in weld quality; over the course of a day, the precision and consistency of a welder's work can ebb and flow due to these natural fluctuations. The consistency and repeatability of the cobot help control the essential variables for ideal welds every time.

## How Cobots Affect Essential Weld Setting Variables

Experienced welders know that many variables influence the quality of a weld. The perfect recipe not only maintains the quality of the welds but also optimizes the use of materials like wire and shielding gas to reduce rework and costs.

"When you improve quality, you have to improve the process, and the robot provides absolute control over the essential variables required in a welding process," said Harris.

The main variables the use of a cobot will affect are as follows:

**TRAVERSE ANGLES** — Traverse angle precision is crucial to ensure the weld bead is deposited correctly to achieve optimal joint penetration and minimize defects such as undercut or excessive reinforcement.

In a production scenario, welders may inadvertently vary the angle due to hand movements or repositioning. On the other hand, cobots are programmed to hold the torch at a set angle, ensuring a uniform weld every time — Fig. 1.

**CONTACT-TIP-TO-WORK DISTANCE** — The distance between the contact tip and the workpiece is crucial. A ¼-in. variance can drop the amperage and significantly affect the joint's integrity.

Because cobots are programmed and can do highly repeatable work, they ensure that the contact-tip-to-work distance remains consistent throughout the welding process and along the weld for tightly toleranced welded components.

**AMPERAGE AND VOLTAGE** — The amperage and voltage ratio is crucial for the quality and uniformity of a weld. A variation in this ratio can result in excessive spatter and weak welds. The contact-tip-to-work distance is a key factor influencing this ratio. So, here again, the control delivered by the cobot will ensure a consistent ratio, preventing excessive spatter and mitigating other quality issues such as porosity, incomplete fusion, and weak welds.

Maintaining all the above-mentioned parameters consistently enhances the overall reliability and efficiency of the welding process and ensures that each weld meets the same high standards.

**TRAVEL SPEED** — Travel speed directly influences production throughput, weld quality, and heat management. When the previously mentioned variables are constant, cobots have significant advantages for maintaining high travel speeds.

"While a human might achieve 12–20 in. per minute at best, a cobot can consistently operate at three to four times that speed," Harris stated.

Faster travel speeds can prevent common welding defects such as melt-through and excessive joint penetration — Fig. 2.

**DEPOSITION RATE** — The metal deposition rate dictates the welding speed and creates the limiting step for arc-on conditions. Cobots make it easier to achieve a consistent deposition rate through providing constant robot travel speed and wire feed speed. A more consistent deposition rate enables faster metal deposition, increasing welding speeds while protecting joint quality.

**SHIELDING GAS** — Proper use of shielding gas is essential in welding for both quality and cost. Overwelding, which is common in the industry, leads to excessive gas usage, wasting nearly 500% more gas than needed in a given year. Incorporating a cobot into the welding process can significantly mitigate this issue. Its consistent control optimizes shielding gas usage and ensures that only the necessary amount is used for each weld.

*Fig. 1 — Cobots are programmed to hold the torch at a set angle, ensuring a uniform weld every time.*

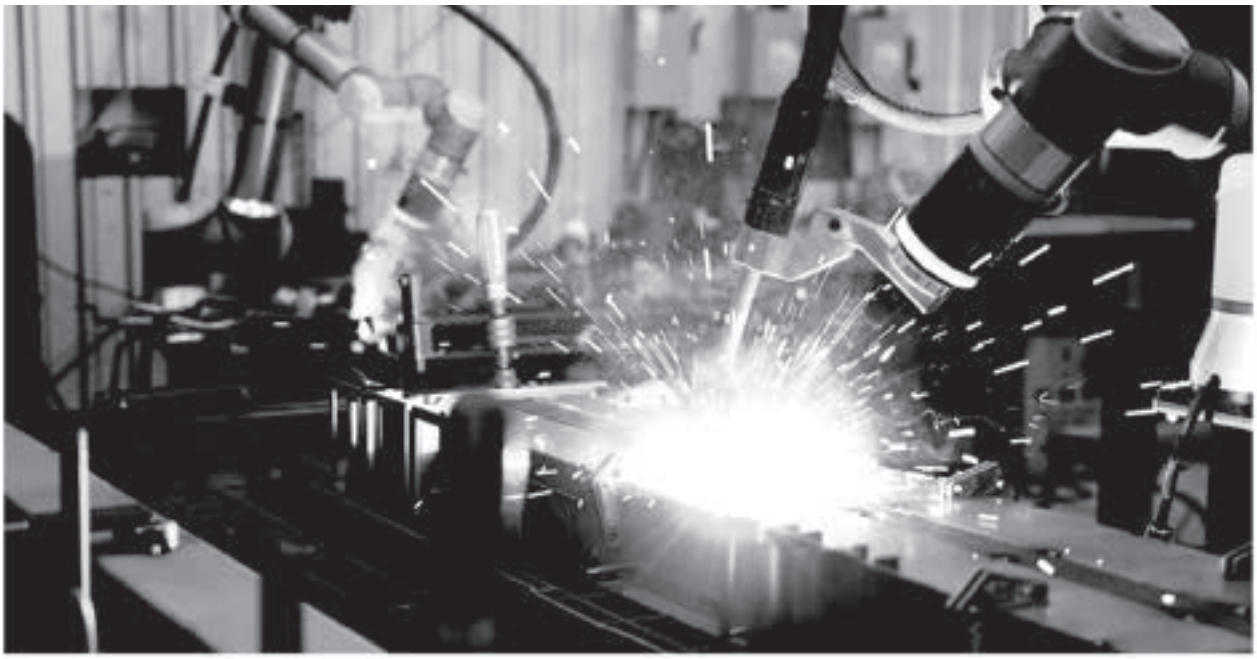


*Fig. 2 — The precise control cobots provide makes the process more stable and predictable and leads to consistent, high-quality welds.*

## Performance at Optimized Settings — Manual vs. Cobot

Cobots allow companies to set and optimize their welding process by working with more constant parameters. The welding speed can be increased while achieving the required weld specs and quality. Moreover, the whole welding process is more cost-effective and productive with fewer mistakes, reduced waste, and lower rework.

### Productivity

In manual welding, the operator factor, or the actual arc-on time, which directly impacts cost efficiency, can be surprisingly low. The industry standard average operator factor is approximately 10 to 12%, with the highest being 20%. For a 10-hour day, this translates to 60 minutes of arc-on time.

Cobots drastically change this operator factor dynamic. "With a robot, you train it and it never stops. It doesn't have to raise its hood to move from one joint to another. It just automatically goes because that's the way it was taught," Harris said.

Cobots can significantly increase the operator factor by maintaining continuous operation, potentially tripling the arc-on time compared to manual welding.

### Cost Savings

Being able to set and optimize your welding process will result in big financial gains on multiple fronts.

"If my amps are too high or my volts are too high for my amperage, I'll get a lot of spatter. A lot of spatter costs millions of dollars every day in our industries," Harris explained.

Spatter cleanup and weld repair add substantial labor time, driving up the costs. The control the cobot delivers prevents excessive spatter and mitigates other quality issues such as porosity, incomplete fusion, and weak welds.

Cobots optimize the recipe of filler metal, speed, angles, and shielding gas to maximize welding efficiency. This benefit also avoids unnecessary expenses that occur through overwelding.

## Conclusion

The use of cobots in welding marks an exciting era where technology meets skill. These robots, programmed by skilled operators, are changing the industry. They bring a level of consistency and efficiency that's hard to achieve by manual welding.

Cobots relieve skilled welders from repetitive and physically demanding tasks and allow them to focus on more complex aspects of welding that require insight and decision-making skills.

More importantly, the cost-effectiveness brought about by cobots through reduced material waste and lower rework rates adds a significant financial aspect to their value. These benefits make them an indispensable asset in modern welding operations.

As we embrace cobots, we're not just keeping up with technological trends; we're actively shaping a future where efficiency and expertise go hand in hand. WJ

**KYANNE PEEK** (*kpeek@hirobotics.com*) is applications manager, Hirobotics, Nashville, Tenn.

# 2024 AWS POSTER COMPETITION AT FABTECH

## October 15-17 | Orange County Convention Center | Orlando, FL

The AWS Poster Competition is a key component of the AWS Professional Program. Visual displays of technical or business projects are welcome for inclusion in the competition. Authors are invited to submit a video (3 to 4 minutes) along with their poster. Posters and videos will present results from welding and additive manufacturing (AM) related studies, which are best conveyed visually, as well as research results involving study and analysis of graphs, micrographs, tables, or CAD drawings.

**Submissions are welcomed in five categories:**

- **Students in High School Welding Programs**
- **High School Students in University Research Programs**
- **Students in Two-Year College or Certificate Programs**
- **Undergraduate Students in Four-Year Programs**
- **Graduate Students**
- **Professionals**

**Prizes for each category:**

**1st Place: $750**
**2nd Place: $500**
**3rd Place: $300**

Plaques for top 3 places

### Requirements and judging criteria:

- **Posters must be submitted online.** Follow the guidelines through the link below.
- Find more information about submission, design guidelines, judging criteria, lists of topics, and general tips at ***https://www.aws.org/Community-and-Events/Conferences-and-Events/Posters-Competition/***
- Instructions for the submission of videos will be available on the website.
- Technical topics relevant to the welding industry are acceptable (business studies, welding processes and controls, welding procedures, welding design, structural integrity related to welding, weld inspection, welding metallurgy, and AM).
- Posters and videos accepted for the competition will be judged based on technical content, clarity of communication, novelty/relevance of the subject, and overall aesthetic impression.

### Goals of the competition include:

- Advancing the science, technology, and application of welding and allied joining and cutting processes, including additive manufacturing (AM), through visual communication of work undertaken to address technical and commercial challenges.
- Highlight investigative work in the above mentioned fields by recognizing the investigators and institutions that support these endeavors.
- Promoting the development of students' communication skills and knowledge of welding, AM, and related technologies.

# Submission Deadline: July 31, 2024

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BY ALEXANDRA QUIÑONES

# THE WELDING ADVOCATE

## *Tiffany Orff is a multibusiness owner and prison vocational teacher who shares the word about welding*

*During her 14 years in the welding industry, Tiffany Orff has worn many hats, including business owner, teacher, and advocate.*

The first time Tiffany Orff welded a solo project, she didn't know it would alter the course of her life. She had been working at Custom Industries, a custom suspension/fabrication shop in Riverside, Calif., for a few months when the owner, who she was dating, asked her to weld sheet metal floors in a body-dropped Dodge Dakota. She was already hooked on shop life but rarely had the opportunity to take the lead on welding projects.

"It went from [being the] girlfriend to 'hand me that tool' to welding sheet metal very quickly while I worked side by side with the owner," Orff said.

Within a year, Orff gained proficiency in welding and became co-owner of the shop. She and her partner then rebranded the shop and moved to Booneville, Ark. Orff went on to get a formal education in welding at Arkansas Tech University — Ozark, Russellville, Ark. During her time at the university, she won gold for welding fabrication at the 2018 Arkansas SkillsUSA Championship, graduated with honors and an associate degree in welding technology, and received the Arkansas House of Representative Award of Recognition, along with several grants and certifications. Orff's achievements are in great part due to her love of welding, but she is diligent by nature; she gives her all to whatever she does, and she has done a lot.

In the years since her early shop days, Orff has become a relentless advocate for welding. She has owned multiple businesses; taught welding at MiraCosta College, Oceanside, Calif.; interviewed with many media outlets; and showcased dozens of women welders via live videos on her online platform, Welding Women Syndicate (WWS).

Orff recently spoke with the *Welding Journal* about her life these days. She now lives in Salinas, Calif., and works as a welding instructor for the California Department of Corrections & Rehabilitation (CDCR). She teaches private welding lessons at night, and on the weekends, she

*Orff won the 2022 AWS WEMCO award for excellence in welding media for the Welding Women Syndicate.*

moonlights at a hot rod shop building cars. Orff also occasionally visits high schools and facilities to teach or lecture students from various welding programs.

Her life revolves around welding, and she wouldn't have it any other way.

## A Voice for Women

From when she started working at Custom Industries until she went to college — a period of eight years — Orff did not work with any women. This inspired her to start the WWS, which won Orff the 2022 AWS Welding Equipment Manufacturers Committee (WEMCO) award for excellence in welding media. In addition to being an online space to support, highlight, and attract women to the welding industry, the WWS is an LLC that serves as the umbrella company for her other ventures. WWS has a physical location that is home to another of Orff's businesses, the Exploratory Academy, where she holds private welding classes.

Although she has highlighted many women welders via the WWS Instagram page (*@welding_women_syndicate*), Orff feels there's still more work to do to bring women into the industry.

"Just because we have the privilege of social media, it feels like there are so many more women in this industry," Orff said. "I still don't work with any, primarily because I'm now in a men's prison. But even still, unless I was hiring the people at my own shop or actively sought out women, there are still very few women in the welding industry. The only thing is we have a bigger voice due to social media and people actively championing for us."

She is quick to point out that welding isn't a male-dominated industry; it's male populated. Reframing that often-repeated phrase can make welding feel more inviting to women, but Orff would like to see an industry-wide mindset change to be more inclusive. She believes that women are still subjected to traditional gender norms and not widely embraced in the industry, evidenced by the lack of accommodations, such as women's bathroom amenities and clothing options, offered by employers.

For the time being, Orff has taken a break from doing live interviews on Instagram, but she is still working on the WWS, with her efforts being more concentrated on local, in-person outreach.

## Arcs behind Bars

Lately, Orff has found herself in another male-populated environment: Correctional Training Facility, Soledad, Calif., a men's Level II prison where she teaches welding to inmates.

Working in a prison can come with a stigma, but Orff emphasized that she has not experienced any incidents, and her students are grateful for the opportunity to learn a trade. The group of inmates she teaches is slated to be released in the next three to five years, and they work with counselors in rehabilitation programs, so there's less chance of recidivism, which is also reduced by learning a vocation.

In the prison's vocational welding program, students can earn National Center for Construction Education & Research (NCCER) and AWS certifications. According to Orff, the inmates in her class have high test rates, with scores regularly between 85 and 100%.

"People come in all the time, and they congratulate me on the fact that [the inmates] are so focused on the program because they're making something, they're breaking something because we do bend tests, they're fixing something, or they're helping each other study," Orff shared.

For Orff, the best part of the job is when the inmates tell her they've found a purpose.

"I had one student come in, and he was like, 'Now I know what I can do for my family. I'm going to provide for them by welding,'" Orff said. "I can't even tell you how much satisfaction I get from hearing that because that's what [welding has] done for me. It's given me purpose. I provide for my family. It's supported me. It's brought me up when I was down . . . So, to see them have some kind of hope, and I've given them a little bit of that, God, it's better than anything I could ever articulate."

The student inmates aren't the only ones getting an education. Orff revealed that she learns from them every day. Her lessons have included being more patient, listening more, and not judging a book by its cover. The inmates' dedication to starting a new life has even inspired Orff to host a collaboration with the prison and the community. The event is still an idea, but the purpose would be to shine a light on how the inmates work for their rehabilitation and to let the outside world see what it is like inside the prison system.

"Nobody's making [the inmates] do this," Orff affirmed. "They do it of their own free will."

Orff leads a BattleBots class.

## Slowing Down

Despite having a full plate, Orff's current life is a pared-down version compared to when she owned her shop and was in the process of starting a welding school. WWS was originally housed in a larger building that held public classes, and Orff was working on getting the facility accredited. But the workload wore on her, and she felt the need to slow down and simplify her life. That's when she started working at the prison and moved her business to a smaller facility to focus on private lessons.

"I just took more time for myself lately, in the past few months," Orff said. "It's important. It's something I didn't even realize I needed, to be quite honest. But you give so much to others, you don't necessarily fill up your own cup."

Her goal for the next year is to collaborate with a few more small fab shops to bring more women and youth into metal-work and welding. Although she has lightened her workload, Orff still lives and breathes welding with a contagious passion.

"I really, truly believe in the industry," Orff shared. "It has provided for me so richly in the sense that it's paid my bills, supported my family, given me confidence as a human being, and given me such a full life. I want that for everybody." WJ

**ALEXANDRA QUIÑONES** (*aquinones@aws.org*) is associate editor of the *Welding Journal*.

Datasheet 415

# Safety in Robotic Operations

A robotic welding system consists of a manipulator; a power source; an arc welding torch and accessories; an electrode feed system; a dereeling system, welding circuit, shielding and communication control; and grounding system.

## Potential Hazards

Potential hazards to personnel from robotic welding units shall be eliminated by design through protection such as safeguarding and work procedures. If a hazard cannot be eliminated by either design or protection, a warning against the specific hazard shall be provided.

The operational characteristics of robots can be significantly different from other machines and equipment. Robots are capable of high-energy movements through a large volume of space, even beyond the base dimensions of the robot. Any change to the object being worked or the environment can affect the programmed movements.

Some maintenance and programming personnel may be required to be within the restricted envelope while power is available to actuators. The restricted envelope of the robot can overlap a portion of the restricted envelope of other robots or work zones of other industrial machines and related equipment. Therefore, a worker can be hit by one robot while working on another, trapped between them or peripheral equipment, or hit by flying objects released by the gripper.

A robot with two or more resident programs can find the current operating program erroneously calling another existing program with different operating parameters, such as velocity, acceleration, deceleration, or position within the robot's restricted envelope. This might not be predictable by maintenance or programming personnel working with the robot. A component malfunction could also cause unpredictable movement and/or robot arm velocity.

Additional hazards can also result from the malfunction of, or errors in, interfacing or programming of other processes or peripheral equipment. The operating changes with the process being performed or the breakdown of conveyors, clamping mechanisms, or process sensors could cause the robot to react differently.

## Risk Assessment

Before work with robotic welding systems can begin, the employer is required to perform a risk assessment on the arc welding robot system and ancillary equipment to determine and select the safeguarding necessary to achieve and maintain a safe work environment. The risk assessment shall comply with AWS D16.1, *Specification for Robotic Arc Welding Safety*. It shall consist of an application description, robotic operating characteristics, robot classification, categories of hazards, risk analysis, documentation, and training required. The risk assessment process shall be performed and maintained by qualified individuals who have been trained in understanding robotic arc welding application design, methodology of classifying arc welding robots, methodology of identifying operating characteristics, and information concerning the proper use of minimum safeguarding protocols. The risk assessment should be reviewed and revised, if necessary, at least annually and any time changes take place in equipment or processes. The risk assessment should be available for review by anyone at any time. A sample risk assessment form may be found in AWS D16.3:2009, *Risk Assessment Guide for Robotic Arc Welding*, Annex C.

## Training

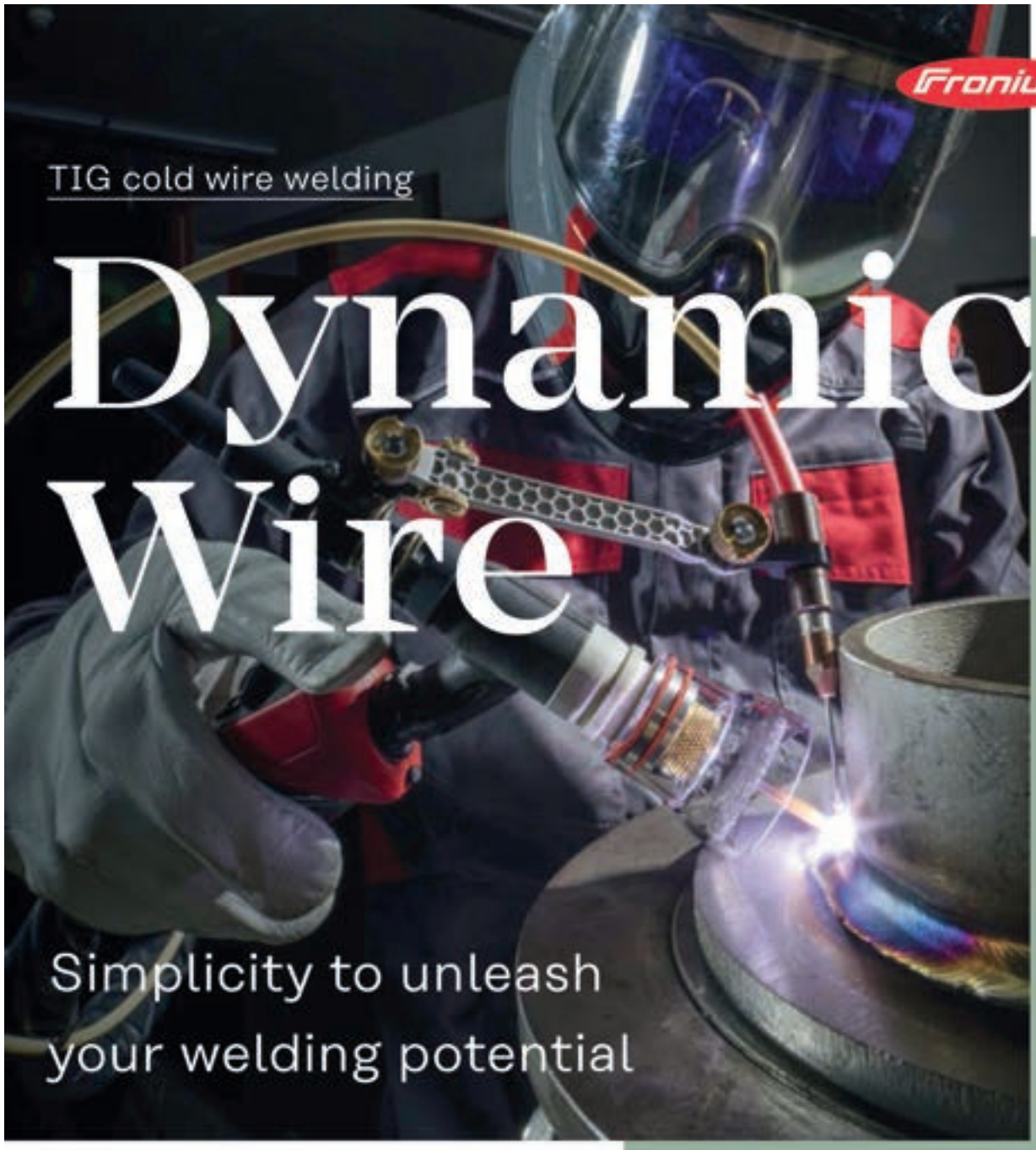
Once the risk assessment is complete, training on the overall system, component safety, and safe operation must take place. All operators, maintenance personnel, welding inspectors, welding supervisors, and safety personnel should receive the training, and it should include a review of the risk assessment as well as the manufacturer's operation manual and safety information. Management and engineering personnel may also receive the training as required. Should a risk assessment be revised, all applicable personnel should receive refresher training on the new risk assessment.

Robots or robotic systems must comply with the following regulations: Occupational Safety and Health Administration, OSHA 29 CFR 1910.333, *Selection and Use of Work Practices*, and OSHA 29 CFR 1910.147, *The Control of Hazardous Energy (Lockout/Tagout)*, and personnel should be trained to these standards.

Personnel who program, operate, maintain, or repair robots or robot systems should receive adequate safety training, and they should be able to demonstrate their competence to perform their jobs safely. Employers can refer to OSHA's publication 2254 (Revised), *Training Requirements in OSHA Standards*.

Additionally, employers should provide training for operators, programmers, and maintenance personnel to help them attain and maintain certifications such as the AWS Certified Robotic Arc Welding Technician/Operator Program. WJ

*Excerpted from the Welding Handbook, Tenth Edition, Volume 1, Welding Science and Technology, Chapter 17—Safe Practices.*




The innovative advantage of Fronius TIG DynamicWire, when compared to a conventional continuous wire feed in cold wire systems, lies in its automatic self-regulation. The power source actively adjusts the wire speed to the welding behavior, torch position, and current conditions, even compensating automatically for component tolerances of up to 30%. The result? Perfect welds every time. Existing iWave cold wire systems can be easily upgraded with the patented TIG DynamicWire Welding Package through software activation.

For further information, visit:
www.fronius.com/tig-dynamicwire

# THE INDIAN INSTITUTE OF WELDING

## Authorised Nominated Body - ANB

## Information Brochure for Enrolment

# INTERNATIONAL WELDER

**A Division of The Indian Institute of Welding** has been accredited by IIW as its only **'Authorised Nominated Body' (ANB)** in India (referred to as **ANB-India**) to operate its international schemes and award **International Diplomas** on **Welding** to personnel at various responsibility and job levels including International Welder for different processes at three skill levels. The Indian Institute of Welding in turn can appoint welder training Institutes in different parts of the country as **Approved Training Bodies (ATBs)** to impart the practical and theoretical training programmes. Prospective candidates are required to undergo training in these ATBs in the welding course of their choice following a prescribed theory and practical curriculum.

## 1.0 Benefits

**Career for Welders:** Welding is a widely used skill offering opportunities to build careers in fabrication & construction. People starting out through practical welding qualifications can achieve high level welding skills which are greatly sought after and they need not stagnate in welder's jobs if they wish to further develop their careers. There is enormous scope to obtain overseas appointment at all levels for IIW Diploma holders apart from within India.'International Welder' Diploma includes additional certification for practical skill qualification as per ISO 9606.

## 2.0 International Welder Curriculum

The detailed course content & eligibility form part of the guideline **IAB-089r5-2014** or latest edition (Part 1) of the IIW-International Authorisation Board **(IAB)**.

**For the International Welder course:** The Diploma Certificate issued specifies 3 levels of increasing knowledge & skill as International **Fillet Welder (IFW), International Plate Welder (IPW), International Tube** (Pipe) **Welder (ITW)** taking into account the welding process and material to be welded. A person having completed all the three levels in a process and passed the ANB conducted examination in written & practical test is entitled for a Comprehensive Welder Diploma Certificate. For details visit website link:
https://iiwindia.com/personnel-qualification-certification/certification/welder/

### 2.1 Theoretical:

The theoretical education and training programme consist of 3 theory modules **A, B** and **C** (for ITW only) The candidates also have to undergo an additional module **'S'** depending on the welding process of their choice as offered at the ATB and *may also select an optional module* **'P'** *for base material(Aluminium, Stainless Steel)* other than carbon steel & low alloy steel, which are the normal materials used for welding training.

### 2.3 Practical:

There are 6 practical training and tests modules or processes covering the various welding processes and materials which are listed to the requirements of ISO: 9606 standards for approval testing of welders.

| | | | |
|---|---|---|---|
| **Process 111** | (MMAW) | : | MMA welding of Ferritic & Stainless Steel |
| **Process 135,136,138** | (GMAW) | : | MAG welding of Ferritic & Stainless Steel |
| **Process 141** | (GTAW) | : | TIG welding of Ferritic & Stainless Steel, |
| **Process 131** | (GMAW) | : | MIG welding of Aluminium *(if offered by ATB)* |

## 3.0 International Welder (Eligibility for Admission in an ATB)

**Eligibility Criteria for Module-1 – ref IAB Guideline 089 (Access Condition-Entry Level)**

- Must have completed Secondary Education (Class X) from a State or Central Board, or equivalent with ability to comprehend written/oral instructions in English.
- Must possess appropriate health, physical and mental capability i.e. no physical or mental disability that precludes safe operation of welding equipment or interferes with full performance of duties in industry.
- Minimum age requirements prescribed in the State and Indian Central Labour Laws applicable in the state in which the ATB is located.
- Must have some background experience/knowledge in industry. Basic skill in metal working is required as a pre-qualification.

## 4.0 Procedure For Enrolment, Registration & Training

- **ANB India** controls admission to all IIW courses as per eligibility requirements of the "Access Conditions" and subsequent registration process, examination, testing and final award of International Welder Diploma and Certification on practical welding skill.
- The actual theoretical lesson and practical training is conducted by the Approved Training Body (ATB). For convenience, the application/registration Forms are available with the ATB and may be submitted through them. After successful theoretical and practical examination, the Authorized National Body awards an 'International Welder' Diploma to the candidate specifying the process, level and material (if applicable).
- Prospective candidates are advised to refer to ATB for details of course fees including practical training fees is to be paid to the ATB and other charges payable to ANB for Registration and conduct of Examination and practical test for IW Diploma.
- Interested candidates may contact directly as below;
  1. **Don Bosco Technical Institute,** Chittoor Road, Vaduthala, Kochi 682023
     Principal - Fr Raju Philip sdb, Mob: +919483360106, E Mail: unnaramkallel@gmail.com
     Other Contact: Preethy James (+91 9446029120), E Mail: dbprojectsvaduthala@gmail.com
  2. **ADOR Welding Training Division,** Survey No 147/2B +3, Akurdi, Chinchwad, Pune 411019
     Contact: Harshal Borole, +91 9130508311, E-mail : harshalborole@adorians.com

## 5.0 International Welder Examinations, Diploma & Certification

After completion of the modules A, B and C there is a final theoretical examination set under the authority & supervision of the ANB. In addition to the examination of the modules A, B and C, the examination of the specific welding process (S) module and – if applicable – the appropriate material (P) module (Aluminium/SS) is requiredother than carbon steel & low alloy steel.

*Welding skill is tested as per requirements of the IAB guideline and also certified as per ISO 9606-1 under ANB authorised Examiner to ensure compliance.* The appropriate level of Diploma as **(IFW)** or **(IPW)** or **(ITW)** with mention of additional Process (S) & Optional material chosen (P) is awarded after successful finish of Module 2, 4 & 6 respectively or a **Comprehensive Diploma** once all the levels are completed in a particular process. The diploma at any level of 'International Welder' also includes an additional renewable certification for practical skill tests as per ISO 9606 appropriate part.


# The Indian Institute Of Welding - ANB

Authorised Nominated Body of the International Institute of Welding in India

IIW-INDIA HOUSE, PLOT 38, GEETANJALI PARK
200, KALIKAPUR MAIN ROAD, P.O. MUKUNDAPUR, KOLKATA - 700 099, INDIA
Enquiry: enq.anb@iiwindia.com | Web: www.iiwindia.com

# BE A WORLD CLASS MANUFACTURER IN FABRICATION

## The Indian Institute of Welding - ANBCC

## Introduces to Welding Related Industries The Survival Strategy for the 21st Century

In a globalised business environment where the cost and quality competitiveness are increasingly playing the dominant roles, the Indian fabricators using welding should not only be prepared to face more challlnges at home from Imports of finished fabricated products but also be able to compete overseas in order to grow and sustain their viability.

### Manufacturer Certification Scheme - The Quality Requirement for the 21st Century

Many companies have achieved certification to ISO:9001 for their quality management systems. But where significant use of it towards the **special process** (**a process where the conformity to the resulting product cannot be readily or economically verified is referred to as a special process**) like welding, such certification is unlikely to provide the required demonstration of company capability to manufacture products with the 'required' product quality. In such cases compliance to ISO:3834 is the recommended solution. The International Institute of Welding (IIW), as a tool for achieving substantial quality, has introduced a specific **Manufacturers Certification Scheme (MCS)** referring to ISO:3834 for world wide impementation.

### Introduction to ISO : 3834

Processes such as fusion welding are widely used to manufacture many products. In some companies, they are the key process of production. Products may range from simple assemblies to complex fabrication. Examples include pressure vessels, domestic and agricultural equipment, cranes, bridges, transport vehicles, construction of plants and many such other items. It is important, therefore, to ensure that the operational processes are carried out in the most effective way and that appropriate control is exercised on overall aspects of the operation. Quality cannot be inspected in to a product; it has to be built in. Even the most extensive and sophisticated non-destructive testing does not improve the quality of the product.

It is emphasized that ISO:3834 entitled "Quality requirements for fusion welding of metallic materials" is not a quality management system standard replacing ISO:9001, but supplements this. ISO:3834 identifies measures that are applicable for different situations for fusion welding application.

### IIW Manufacturer Certification System Benefits - By Compliance to ISO:3834

**Benefits for Certified Organizations**

- Clear, high profile, independent verification of compliances by the world's leading authority on Welding.
- Confirmation of welding and fabricating capability and staff competence,
- Improved client confidence leading to a reduction in external audits.
- Entry of the company's details on well-publicised International Web site register.
- Quality management and fabrication capability assessment are carried out by IIW recognized assessors.
- Increased national and international business potential.
- Cost savings through reduction of rejection/rework in production.
- Improved delivery with "first time right" approach.
- For many products, mandatory requirement for suppliers to EU and many other countries, and also for the sub-suppliers. Namely the EU Directives and the Harmonised Product Standards.
- Establish the base for implementation of other relevant standards like EN:15085, EN:1090, EN:13445 etc. & CE making

### Authorisation as per certification body

International Institute of Welding (IIW) appoints an Authorised National Body for Company Certification (ANBCC) under its Manufacturers Certification Scheme (MCS) for Compliances to ISO:3834.

IIW-India has obtained accreditation as ANBCC from the International Institute of Welding through its International Authorisation Board (IAB) for the exclusive rights within India to operate its MCS for certification of companies for compliance to the requirements if ISO:3834.

### Specific Advantages of IIWs MCS

- Beside ensuring compliance with the requirements of ISO:3834, it also covers the welding related aspects of
  a) Environment as per ISO:14001 and
  b) Health & Safety as per OHSAS
- Under MSC of IIW, the certificate is valid for 5 years. Renewal of Certificate are carried out after 4 years of surveillance audits, while as per the certification schemes by competitors the Renewal of Certificate are carried out after 2 years of surveillance audits as the new certificate's validity is 3 years.
- As per MCS, it is a mandatory requirement to assess the competence of WCs, which is also a requirement as per new version of ISO:14731:2019

### Levels of Certification

ISO:3834 certification can be achieved in 3 levels of quality requirements.

**ISO:3834-2 Comprehensive quality requirements**

**ISO:3834-3 Standard quality requirements**

**ISO:3834-4 Elementary quality requirements.**

### Steps towards Certification as per ISO:3834

- Gap Analysis
- Awareness Program, including suppliers
- Documentation as per code requirement
- Finalization of RWC from human resource within the organization or otherwise from external source
- Review, decision on new approved suppliers
- Arrange or identify welding related personnel qualification as per code requirement
- Certification of Welders, Certification of Inspectors
- Qualification of Welding Procedures
- Review and upgrade present systems
- International Audit / Review of systems as per code requirement
- Invitation to Certification Body for Certification

## How is ISO:3834 Certification Achieved ?

**Steps to be followed**

**Pre-application Stage**

- **Step 1 -** The intending client sends an enquiry to IIW-India ANBCC
- **Step 2 -** IIW-India sends to the client a letter explaining the pre-application stage, information brochure on ISO:3834, a preliminary form (RFQ)
- **Step 3 -** The client sends back the filled-in RFQ form and request for awareness programme (optional)
- **Step 4 -** Based on the data provided by the client, the ANBCC sends to the client a formal techno-commercial offer/agreement for certification, the exact scope of work, technical requirements and contract, requirements. For implementation of other relevant standard like EN:15085, EN:1090, EN:13445 etc. and CE making. The client sends back the formal acceptance of the contract.
- **Step 5 -** The customer sends back filled-in detailed application form and the quality documents along with the applicable fees to ANBCC.
- Establish the base for implementation of other relevant standards like EN:15085, EN:1090, EN:13445 etc. & CE making.

## Document Audit

The basic documents such as manuals, work instructions etc. which are submitted along with the application, are reviewed for adequacy. At this stage, more documents may be asked by the auditor as necessary. Only after satisfying about the adequacy of documentation, site audit will start.

**Undertake adequacy audit at the discretion of the auditor and if agreed to by the manufacturer.**

## Corrective Action requests

The applicant will be required to take corrective actions within the committed and mutually agreed time for any minor non-conformance found before certification can be granted.

The certification can be granted only after satisfactory closure NCs, as verified by auditor, which may require additional site visit by auditor. If there is any major non-conformance, additional site audit may be required. It is also possible that the audit process will be terminated and the manufacturer has to start the process all over again from application. In case of more than one major non-conformance the case may be closed and fresh application process from client shall start.

IIW-India is committed to the cause of supporting the Indian Fabricating Industry, a key player in projecting India's manufacturing sector as world class with ability to compete on equal terms with global competitors.


**The Indian Institute Of Welding - ANBCC**

Authorised Nominated Body of Company Certification of International Institute of Welding

**Registered Office :**

**IIW-India House, Plot 38, Geetanjali Park**
**200, Kalikapur Main Road**
**P.O. Mukundapur, Kolkata - 700 099, INDIA**
**Tel : +91 33 4006 1837**
**E-mail : anbcc@iiwindia.com**
**oprn.mktg.anbcc@iiwindia.com**
**IIW India Website : http://www.iiwindia.com**


## Certification

ANBCC will issue a certificate of registration to the applicant once the corrective actions have been accepted and / or implemented. The certificate carries a validity of upto five years (max.) from the date of issue.

## Surveillance

During the certificate validity period, surveillance assessments are carried out at an interval of 12 months (max.) at the end of first, second, third and fourth year of the certificate validity.

## Renewal

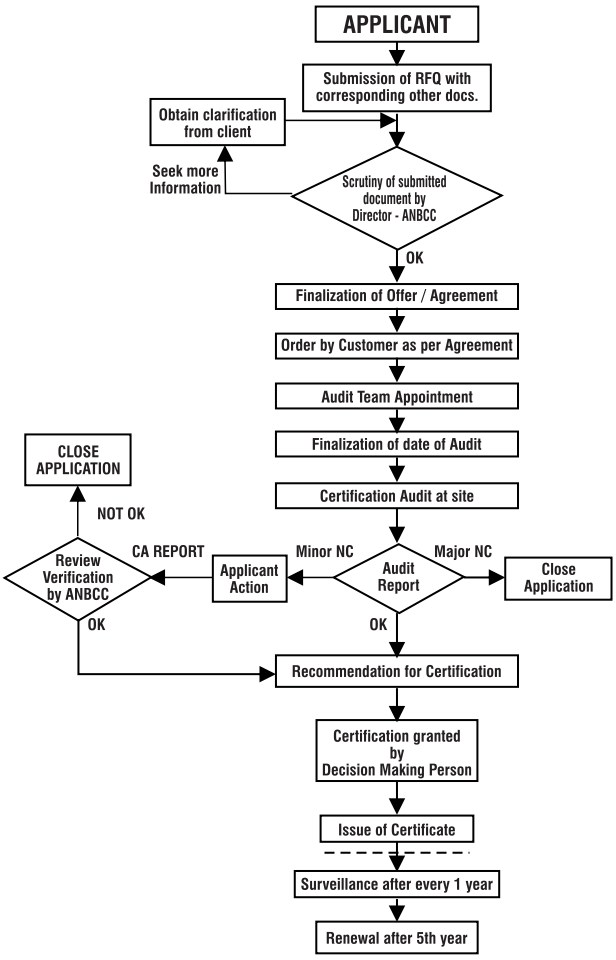
The client's quality system is required to be re-assessed for the renewal of certificate. The re-assessment is carried out before the end of the validity period of certificate. The process steps are same as Certification process.

## Other Services - Direct or through empanelled experts

At the discretion of the Client, Training can be offered by IIW-India - ANBCC in the following areas :

| | | | |
|---|---|---|---|
| i) | Awareness program on ISO:3834 | : | 1 day |
| ii) | Internal Auditor Training on ISO:3834 | : | 2 days |
| iii) | Auditing of suppliers | : | 2-3 days |
| iv) | Comprehensive Training on Implementation of ISO:3834 including the above and gap analysis | : | 4-5 days |
| v) | Customized modules to suit manufcturers requirement. | | |

## ISO:3834 CERTIFICATION PROCESS FLOW CHART : STEPS TO CERTIFICATION



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