WELDING RESEARCH INSTITUTE – *An Overview*

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1.0 Introduction

Against the various inputs essential for balanced growth of industry in developing countries, appropriate technology and infrastructural facilities play a dominant role. Welding plays a crucial and important role in almost every manufacturing and fabrication industry. It is far more widely used than any other production technology. Although the use of welding in India has caught on at a rapid rate in the field of power generation, chemical and fertilizer plants, automobile industry, it still lags far behind the developed countries. An Indo-British team sponsored by the Governments of United Kingdom and India made a survey of Indian process plant manufacturing industries in early 70's and recommended the setting up of a Welding Research Institute. The requirement of welding technology was further analysed in 1972 by a specialist planning group on 'Joining Machinery' under National Committee on Science and Technology (NCST).

The Welding Research Institute was established in 1975 under the aegies of Bharat Heavy Electricals Limited with financial and technical assistance from UNDP and UNIDO. It was decided that the proposed institute would be an application oriented industrial research centre and should have close liaison with various industries in the country. The National Council of Science and Technology also contemplated that besides the Central Institute, three regional centres would be set up to cater to users in different places.

The project was executed in two phases, one from 1976 to 1980 and the other from 1981 to 1984. The necessary experimental facilities and expertise was rapidly established. Since the inception, adequate emphasis was given on systematic training of researchers in specialised areas at advanced centres in India and abroad. They were also exposed to UNIDO experts deputed to the institute from time to time.

The purpose of this paper is to briefly describe the capabilities and infrastructural facilities available at Welding Research Institute so that the expertise available could be effectively utilised by the industries for better and faster progress in the country.

2.0 Objectives

In line with the country's commitment to industrial self-reliance and to bridge the existing gaps in welding technology, WRI has dedicated itself towards fulfilling the following objectives:

(a) To take up in-house R&D in various disciplines of welding such as welding consumables, welding equipments, welding processes, welding metallurgy and welding engineering in order to achieve improvements in productivity and quality.

(b) To carry out sponsored R&D programmes in welding as per the requirements of the user industries.

(c) To function as an effective centre for assimilation of welding information.

(d) To provide educational and training facilities in welding and NDT.

3.0 Facilities

The Institute has under its roof a number of fusion and solid state welding systems such as electron and laser beam welding, flux shielded and gas shielded welding,

resistance spot, projection and seam welding, plasma welding, friction and butt welding etc. The list of welding facilities is given in **Table I.**

TABLE-I

WELDING FACILITIES AVAILABLE AT WRI - TRICHY

Machine (Capacity)

1. Electron Beam Welding Machine(45 kW)
2. Laser Welding Machine (575 W)
3. Friction Welding Machine (115 tons)
4. Ultrasonic Metal Welding Machine (70 0 W)
5. Ultrasonic Plastic Welding Machine (2 kW)
6. Plasma Welding Machine (300 Amps)
7. Plasma Spraying Machine (700 W)
8. Synergic Pulsed MIG Welding Machine (2 kW)
9. Orbital Pipe and Tube Welding Machine 450 mm dia. (200 amps)
10. Pulsed TIG Welding Machine (50 - 180 Amp)
11. Bowl Mill Overlay Machine, 1 Ton, (800 Amps)
12. Flash Butt Welding Machine (250 KVA)
13. Seam Welding Machine (170 KVA)
14. Strip Cladding Machine (1000 Amps)
15. Pilot Plants for Flux and Electrode manufacture.

The Institute also houses in its infrastructure a host of sophisticated laboratory test facilities for performance reliability. These include several mechanical testing systems, scanning electron miscroscope, transmission electron miscroscope, X-ray stress analyser, weldability test equipments such as implant test facility and thermal cycle simulator, modern non-destructive testing facilities like acoustic emission and holography are also available. Using these facilities, WRI is making a constant endeavour to widen the horizon of weldability of materials and to develop welding techniques to the every increasing industrial needs. The list of testing facilities is given in **Table II.**

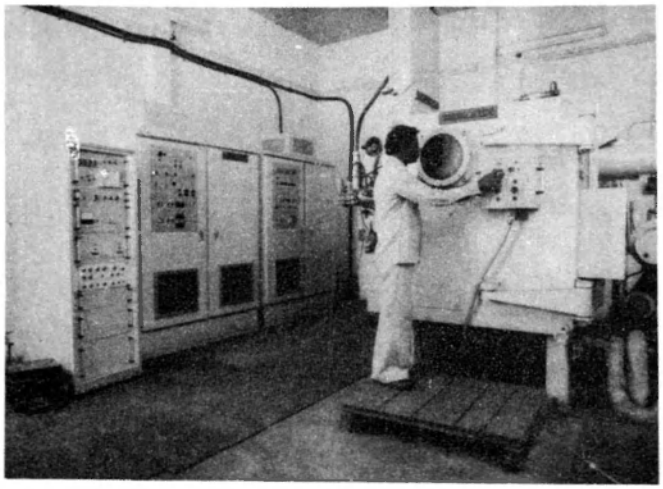

Fig.I Electron beam welding equipment - welding of alloy steel value component in progress

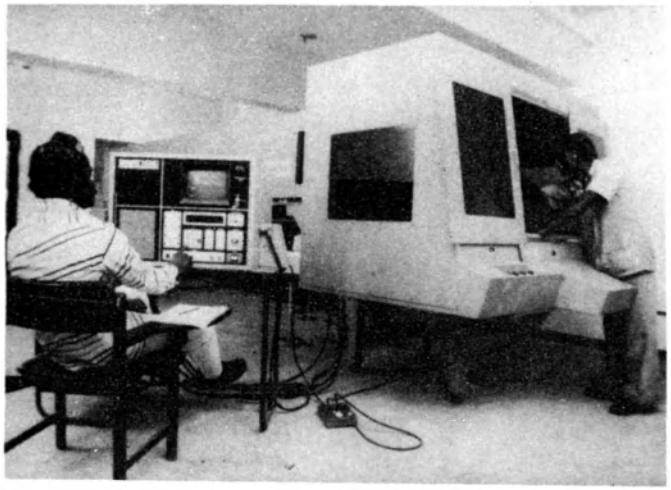

Fig. 2 Laser beam welding equipment - used for later welding, cutting, scribing and surface treatment applications

TABLE-II

FACILITIES FOR WELDMENT CHARACTERISATION AND TESTING

Laboratory Equipment

NEOPHOT-21 Metallurgical Microscope
High Temperature Universal Testing Machine
High Temperature Metallurgical Microscope
Scanning Election Miscroscope with Kevex energy dispersive attachment

TABLE - II *(contd.)*

X-ray Fluorescent Spectrometer
Transmission Electron Miscroscope
Hydrogen determinator
Ferritescope
Thermal Cycle Simulator

Testing Equipment

X-ray Stress Analyser
Instron - Static/Dynamic Testing Machine
Pellini Drop Weight Testing Machine
Implant Machine for weldability testing
Arc Welding Analyser System
Acoustic Emission Monitoring System
Acoustic Holography facility
Portable Helium Leak Detector
Fatigue Testing Machine

4.0 In-House R & D Activities

Over the past one decade, WRI is actively carrying out R&D works related to almost all welding processes and welding systems.

A pulsing module for TIG welding of tubes and pipes has been developed and sub-licensed. A resistance welding monitor has been developed to have in-process quality control check. The effectiveness of this monitor has been successfully demonstrated to some of the automobile and electrical industries. A straight tube butt welder using TIG process has been designed and fabricated for automatic welding of small diameter tubes with infeed-outfeed systems. Automatic electro gas welding machine has been successfully developed by WRI. It is capable of welding plates upto 30 mm thickness in vertical position. This developmental work is presently being extended to higher thickness welding capability. An inertia friction welding equipment was developed for welding of dissimilar metals. Considering the latest trends in the field of welding, WRI is actively involved in the indigenous development of narrow gap welding technology. Projects on narrow gap MIG, TIG and submerged arc welding processes are currently under progress and work on narrow gap MIG welding is in advanced stage of completion.

Apart from the above, a major thrust has been in the area of welding consumables development. A special purpose hardfacing electrode for sugar mill rollers has been developed by WRI and know-how transfer agreements for these and other general purpose electrodes have recently been effected.

Development of special fluxes is another area where WRI is directing its efforts. A special purpose submerged arc high speed flux for the manufacture of LPG cylinders has been developed for which know-how transfer has been effected. Flux formulations have also been extended to develop a fused flux for narrow gap submerged arc welding. This flux has special characteristics like good slag detachability, good bend shape formation and proper side wall fusion. Trials have been successfully conducted with the narrow gap welding machine at BHEL, Bhopal.

An overlaying procedure using submerged arc welding process was developed for reclamation of Ni-hard cast iron bowl mill rolls used for crushing of coal. The entire technology for bowl mill overlaying with high chrome high nickel flux cored wire using SAW process has been established. The flux used in the process has been indigenised and indigenous development of custom-built machines are under progress.

Numerous weldment cracking problems have been studied and solutions given for many fabricating industries. Weldability evaluation of newly developed indigenous steels - micro alloyed and weather resistant steels were carried out for SAIL R&D. These evaluations were done using the sophisticated welding and metallurgical equipments. WRI has also taken up projects on weldability of various non-ferrous materials which include alloys of aluminium, copper and titanium.

WRI has been offering services for welding procedure establishment for critical applications. Recently, a TIG welding procedure was established for aluminium alloy 7020 grade for aerospace application.

Welding design and distortion is another area of specialisation. Recently, detailed studies were carried

out for controlling distortion in 500 MW wind box assembly of boiler using weld sequence method. A transformer tank was fabricated with optimised welding design parameters to control distortion. Similar studies were undertaken and detailed on-line distortion monitoring techniques were developed to control distortion in nuclear steam generator shells.

A weld sequence procedure was also developed to control distortion and deviation in complicated box column fabrication for 500 MW boilers. These activities have enabled the development of adequate user friendly computer software capabilities incorporating weld design, distortion control, residual stress measurements and weld sequencing. A computer software entitled 'FACT' (Fabrication Analysis of Cost and Time) is readily available for usage by other industries who fabricate complex jobs.

5.0 Consultancy Projects

The institute has also been extending its expertise and services to a number of industries in solving their problems. Many troubleshooting problems of a fire fighting nature from various industries were undertaken for welding procedure establishment, quality and productivity studies, design and distortion control, techno-economic studies etc. However, many such problems require appropriate choice of technology and supervision. With the trained manpower, visits are made on priority basis to the customer industry. Such visits and discussions benefit the customer and the institute by providing direction for conducting applied research in relevant areas. Over 280 consultancy projects have been successfully completed and a few major projects successfully handled by WRI are listed sectorwise:

Steel

- Weldability evaluation of high streeength low alloy 'weather resistant steels'.
- Weldability evaluation of SAIL-MA steel.
- Plasma spraying of molybdenum powder on steel mill deflector rolls.

Power

- Failure analysis with the help of scanning elec tron microscope for power plant equipments.
- Evaluation of welding electrodes for welding special Q&T steels used in penstock fabrication.
- Establishment of Nicrobrazing of valves for valves manufacture.

Petro Chemical

- Establishment of procedure for inconel over laying of tube to tube sheet and actual welding for a fertilizer industry.

Nuclear

- Development of the repair welding procedure for feed water nozzle of reactor vessel.
- Evaluation of indigenous inconel strips for overlay.

Aerospace

- Reliability study on ultrasonic testing of 3mm x 1mm tight crack on maraging steel.
- Residual stress measureement on aluminium alloy.

Shipbuilding and Offshore

- Establishment of specialised techniques such as one-sided SAW welding with ceramic flux backing, one-sided MIG welding, autocontact welding etc. for shipyard aplications.
- Preparation of project report for establishment of Welding Technology Centre and training centre for an Offshore project.

Transport

- Techno-economic study and establishment of suitable welding process for the manufacture of wheels. Non-destructive testing of Railway bogies.

- Techno-economic feasibility study on CO_2 welding and seam welding of air reservoir of automobile braking system.

Agriculture

- Repair of sugar mill roller shaft.
- Demonstration and training of personnel in the use of super hardfacing electrodes developed by the Institute for hardfacing of sugar mill rollers at various sugar mills in the country.

General Engineering

- Productivity study on the manufacture of LPG cylinders and recommendations on the modifi cation of the existing fixtures and appropriate welding parameters for LPG cylinder manufacture.
- Investigation on the residual life of early steel girder bridges by fracture mechanics approach.
- Residual stress measurement of spiral welded pipes and seamless steel tubes.
- Testing of about 150 brands of MMAW electrodes as per IS 814 (Part-I & II) for the Bureau of Indian Standards .
- Copper to aluminium welding by flash butt welding.
- Evaluation and testing of SAW fluxes and wires of various manufacturers.
- Repair of 100-year old church bell.

6.0 Training Programmes In Welding Technology

The School of Welding at the WRI conducts training programmes on various topics in welding and NDT for engineers and supervisors from various industries from within the country and abroad. The School of Welding also conducts short-term courses at WRI and special package programmes as per needs of customers at their works.

The details regarding training programmes so far conducted are given in **Table III**.

TABLE-III

TRAINING PROGRAMMES AT WRI

Programmes	No. of Courses Conducted	No. of Participants Attended
Basic Welding Curse for Engineers (8 weeks)	30	340
Basic Welding Course for Supervisors	21	308
Short-term Course on Welding Technology (upto 2 weeks)	118	1532
Package Programmes conducted at Customers' works	40	–

Training programmes for welders in MMAW, SAW, TIG, MIG-CO_2 are arranged right through the year. The training is given on materials like carbon steel, alloy steel, stainless steel plate, pipe and tube in all positions of welding. The welders can also be qualified to execute radiographic quality welds as per different codes of inspection like BS, AWS, DIN etc. The training period will vary from 4 to 15 weeks.

As part of its activity, WRI has prepared two sets of slide albums - one for welders and another for Non-Destructive Testing techniques for technicians. These albums are supplemented by instructors, manuals for transfer of knowledge through lectures. The albums can be supplied to industries/institutions on request.

The institute also brings out a bi-monthly 'KEY-WORDS' journal covering the latest trends in the field of welding.

7.0 Know-How Transfer

Projects that are highly useful and commercially successful have been offered by WRI for commercialisation to derive the maximum benefits. WRI has already transferred the know-how on the following

developments on non-exclusive basis.

Know-How	Transfered to
1. Pulsed TIG Welding Module	M/s Kanubhai Engineers Pvt. Ltd., Bombay
2. Electrode for Hard-facing of Sugar Mill rolls	M/s RCK Electronics Pvt Ltd., Tiruchy
3. TY-103 SAW Flux for High Speed Welding	M/s Jedi Wireflux Ltd Bombay

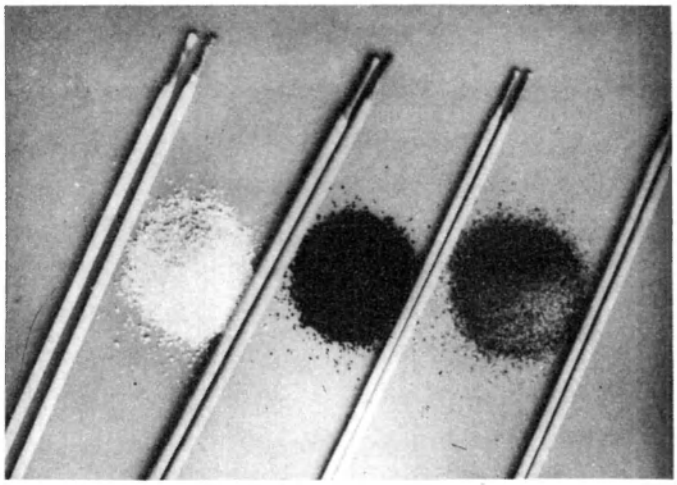

Fig. 3 Special purpose welding electrodes and fluxes developed at WRI

Several other developmental activities have been completed through in-house R&D projects and the items ready for know-how transfer are given in **Table IV.**

TABLE-IV

TECHNOLOGIES READY FOR KNOW-HOW TRANSFER

1. Inertia type friction welding machine
2. Friction welding monitor
3. Resistance welding monitor
4. Straight tube butt welder
5. Automatic vertical electrogas welding machine
6. Narrow gap MIG welding machine
7. Narrow gap SAW welding machine
8. Vacuum packing system
9. Y-type consumable insert facility
10. Pulsed TIG welding module
11. Hot wire TIG welding facility
12. Various types of electrodes for hardfacing applications, stainless steel welding and general purpose welding
13. Submerged arc welding fluxes for high speed welding and narrow gap welding

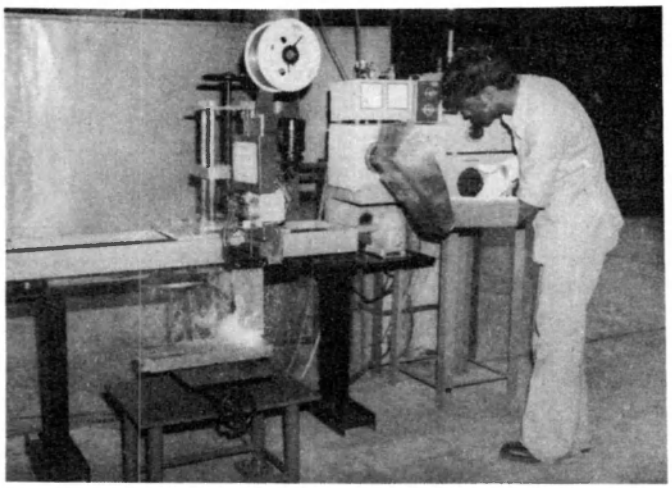

Fig. 4 Narrow gap MIG welding set up developed at WRI.

8.0 Marketing

The results of the developmental work undertaken by the Institute are made available to the industries through the marketing and application efforts for implementation. Some examples are given hereunder:

Item		Customer
1. Resistance Welding Monitor	–	Sundaram Clayton, Madras, Larsen & Toubro, Bombay, Titanium Electrode & Anode Manufacturers, Madras, High Energy Batteries, Tiruchirapalli, Eichur Motors, Indore
2. High Speed Flux	–	2 industries
3. Automatic Voltage	–	Sundaram Clayton,

	Correction Unit	Madras
4.	Hot Wire SAW Attachment	– Mazagon Dock Limited, Bombay
5.	Resistance Welding Controller	– Naval Aircraft Yard, Cochin
6.	Semi Automatic Gas Stelliting	– BHEL, Tiruchirapalli
7.	Vacuum Packing	– Weldcraft Pvt. Ltd. Bangalore

9.0 General

WRI is instrumental in conducting many workshops on welding consumables, welding equipments, welding processes, health and safety in welding and also conferences in conjunction with bodies like Indian Institute of Welding. An Inter-Regional Workshop was organised by WRI in association with UNDP/UNIDO for promoting welding technology in developing countries.

WRI's future programmes in the welding technology are aimed at bridging the gap between India and the developed countries through careful planning and optimum utilisation of men and machinery. Its aim is to achieve better productivity and better quality through judicious choice of automation, introduction of technologies which will eliminate or minimise human errors. Continuous and quick feedback of process errors for correction enhance the capabilities of existing skills of vast manpower through low cost automation etc. The experience and expertise of WRI in these endeavours will be available for sister industries to share.

IWJ

Attention - Immediate

Dear Members,

We are going to publish the current list of membership of our Institute in the journal - July issue.

We, therefore, request you to ensure that your membership subscription is paid immediately for renewal upto current year, 1989-90.

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Editor IWJ.