Standards as a Prerequisite for the Development of the Welding Industry

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Welding is essentially a method of joining two metal pieces without holding then together by a third one. This elimination of the third agency has made welding so important today, and its versatility has facilitated its adoption in almost all the fields of industry. Although limited in its earlier applications to smaller and less important jobs, welding as a joining method has been capturing an ever widening field since the second half of the 20th century. In many countries welding has since been so developed that riveting has been laid off almost completely.

The development of industry takes place in phases, the first phase being research. The prompting for research may be from the scientist whose thirst for knowledge is not satisfied or from the engineer whose aim is always beyond his grasp. This is true in the field of welding as in any other. Research and development are continuous processes. When the industry is satisfied with the results of research, it is normally passed on to the technical committee of the National Standards Body. The deliberations of these committees result in a standard—be it a specification, a code of practice or a procedure manual.

With the increased tempo of industrialization it is very difficult for engineers and technologists to keep pace with the developments in the field of welding. Often National Standards Bodies are approached for guidance, regarding choice of process, choice of electrodes, edge preparation, pre-and-post weld heat treatment, application of various welding processes to different jobs, etc. Standards which are the result of research and experience, therefore, serve as useful guides prescribing the best practice followed in the field.

Standardization in the Field of Welding in India

Until the early fifties the use of welding in our country had been restricted to minor jobs, like repair of existing structures, railway tracks and fabrication of small structural components. Riveting and bolting were still the only accepted methods of fabrication. There were a few documents like codes of practice and specifications used by some departments. The origin of welding standardization and due recognition of welding as a mode of fabrication can be traced to the year 1950 when ISI undertook a comprehensive programme of preparing standards in this field to achieve economy in steel.

India has been experiencing steel scarcity for many years. The need for increase in steel production and conservation of steel through efficient use of available sources received the attention of the Planning Commission from the very early stages of the country's First Five Year Plan period. In 1954, at the instance of the Planning Commission, ISI took up a Steel Economy Project involving formulation and implementation of Indian Standards relating to the production and use of steel. Earlier a special committee appointed by the Institution of Engineers (India) had made recommendations regarding the manner in which steel economy could be achieved. One of the recommendations was the popularization of welding in place of riveting for fabrication.

After years of continuous study and deliberations by expert panels and study groups a number of Indian Standards in the field of steel production, design and its use have been formulated. The technical committee of ISI entrusted with this work was of the view that if all the standards published were fully implemented, a saving of upto 25 percent in structural steel could be achieved. The National Council for Applied Economic Research at the instance of ISI, conducted a study to make a more detailed and objective assessment of the possible savings in steel through standardization. This study revealed that the saving would amount to 23.6 percent of the net tonnage of fabricated structures. This percentage was derived for the Second Plan period under the following heads :

(a) Standardization, rationalization and redesigning of steel structures with IS sections and adopting the published codes of practices,
(b) adoption of tubular construction,

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(c) adoption of cold formed light gauge section, and
(d) increased use of welding.

The break-up of the overall savings that could have been effected in the Second Plan period is given below :

	Description	*Possible Savings (Tonnes)*
(a)	Standardization, rationalization and redesigning of steel structures with IS sections and adopting the published codes of practice	28,505
(b)	Adoption of tubular construction	6.348
(c)	Adoption of cold formed light gauge section	19.476
(d)	Increased use of welding	104.150
	TOTAL	158.479

It will be observed from the table that over 60 percent of the savings could be from increased use of welding for structural fabrication.

Standards in Welding

A survey carried out to assess the status of welding, technical know-how, training facilities and codes of practice revealed that there were only a few departmental publications giving authentic information on welding. There was also no organized method of training and testing of welders, nor codes of practice for inspection and testing of welded components. Therefore, the primary task of the technical committee of ISI was to formulate on a priority basis.

(a) Specifications for welding materials ;
(b) Codes of practice for training and testing of welders, and
(c) Codes of practice for testing of welds.

The committee also concluded that besides formulating standards, handbooks should be prepared so that welding engineers, supervisors and operators could have a proper appreciation of the problems involved in welding. A large number of specifications have since been prepared (*Readers are referred to the January 1969 and subsequent issue of IWJ for a list of IS standards relating to welding—Ed*).

Training and Testing of Welders

One of the problems first encountered by the technical committee of ISI was that there was no accepted standard method of training and testing of welders. In the same way as any other craftsman, a welder has to be trained and tested for a specific job. With a number of welding schools spread all over the country, the necessity for a unified method of training was felt so that the training imparted and certificates issued by such authorities would be valid all over the country. This resulted in the publication of IS : 817 'Code of practice for training and testing of metal arc welders'. Most of the Industrial Training Institutes, welding schools run by some electrode manufacturers and certifying authorities like National Test House are following the syllabus and scheme of training specified in this standard.

The tests for general qualification of welders are specified in IS : 1181-1967 'Qualifying tests for metal arc welders (engaged in welding structures other than pipes)'. A welder is required to pass additional tests to qualify him to work on specific jobs. It is, therefore, proposed to formulate in the near future, codes of practice and qualifying tests for welders engaged in special jobs like fabrication of boilers and vessels, aircraft and ship-building etc.

Welding Consumables

Oxy-acetylene and manual metal arc welding still continue to be the major welding processes in the country. The aim of the welding engineer is to get a weld metal as similar as possible to the base metal in chemical composition and mechanical properties. The importance of selection of the right type of filler materials need not, therefore, be emphasised.

With a number of electrode manufacturing units already set up and many more in the offing, each with technical know-how from a different foreign country, the need for a unified classification of electrodes was felt. As a result, IS : 815-1966 'Classification and coding of covered electrodes, for metal arc welding of mild steel and low alloy high-tensile steel' has been published. The classification which is similar to the corresponding BS classification has been made more comprehensive with the introduction of three more digits to indicate the mechanical properties of the weld metal. In spite of the criticism that the IS classification is laborious because of the greater number of digits, its advantages are obvious.

In a large modern fabrication shop handling sophisticated jobs, storage of different types of electrodes without mixing up is a problem. In some countries this problem has been solved by printing on

each and every piece of electrode its brand name and designation. While such costly and sophisticated methods of marking cannot be practised in our country, it is proposed to standardise for the time being on a scheme of colour coding. A draft standard prepared by an ISI committee specifies colour coding at three points, at the tip, on the brushed end and on the body of the electrode. Mild steel electrodes which form the major part of electrode production will have only their tips marked. Special electrodes, such as alloy steel electrodes, will have all the three markings.

Our country is now reaching self-sufficiency in electrodes. Our electrode manufacturers can now produce general purpose and special electrodes to any specification. In order to assist the industry in this regard, a number of specifications relating to consumables such as

(a) Steel for electrode core wire,
(b) manual arc welding electrodes,
(c) filler wires and rods for TIG welding,
(d) filler rods for gas welding, and
(e) brazing alloys, etc.

have been formulated. Standards under preparation cover surfacing electrodes, stainless steel electrodes and bare electrode wire for MIG welding.

Welding Processes and Applications

In view of the rapid developments in the field engineers and designers have often experienced difficulties in obtaining necessary data regarding the various welding processes and their applications with a view to achieving high productivity and product excellence, Standard codes of practice which are the result of research, experience and practices followed in the industrially advanced countries would be a solution to this problem. A large number of codes of practice specially emphasising the processes which are more commonly used in our country have already been formulated.

One of the important codes published is IS : 823-1964 'Code of procedure for manual metal arc welding of mild steel'. This code, among other things, covers choice of parent metal, types and sizes of electrodes to be used, welding sequence and technique, weld defects, their remedy and acceptance limits. The earliest Indian Standard code of practice published (IS : 816) relates to the use of metal arc welding for general construction in mild steel. As a supplement to IS : 816-1956 another code of practice (IS : 1024-1968) containing provisions for use of welding in dynamically loaded structures has been published. Other important codes published are IS : 2751-1966 dealing with welding of mild steel bars for reinforced concrete construction and IS : 3525-1966 dealing with the use of welding in hull construction of merchant ships in mild steel. Among the various codes of practice under preparation, mention may be made of the code of practice for general pipeline welding, the code of practice for design, fabrication, inspection and testing of penstock pipes, and the code for unfired pressure vessels. To give the welding craftsman the basic concept of welding metallurgy and processes a handbook on manual metal arc welding has been published. It is proposed to publish a number of handbooks to assist welding engineers, supervisors and inspectors.

Testing and Inspection

Welding is an art and its quality is very much dependent on the skill and experience of the welder Testing and inspection, therefore, assume great importance in the field of welding in order to provide sufficient confidence in the minds of the users. It is also important that inspection of welded components is carried out thoroughly in order to locate any possible defects that might have been developed during the course of welding either in the weld or in the parent metal. In order to evolve acceptable and sound testing and inspection procedures the following Indian Standards have been formulated :

(a) IS : 3600-1966 Code of procedure for testing of fusion welded joints and weld metal in steel.

(b) IS : 1182-1967 General recommendations for radiographic examination of fusion welded joints.

(c) IS : 3613-1966 Acceptance tests for wire flux combination for submerged arc welding (with Amendment No. 1).

(d) IS : 2595-1963 Code of practices for radiographic testing.

(e) IS : 4260-1967 Recommended practice for ultrasonic testing of welds in ferritic steel.

A code of practice for inspection of welding is under preparation.

In the field of non-destructive testing, interpretation of the test is largely dependent on personal factors. Attempts are, therefore, being made to minimise

personal factors by publishing suitableaids like reference radiographs.

Equipment

A number of organizations have started manufacturing welding equipment and welding accessories. The following Indian Standards have been published to assist the welding equipment industry :

(a) IS : 1851-1966 Specification for arc welding transformer Part I, single operator type.

(b) IS : 2635-1964 Specification for DC electric welding generators.

(c) IS : 2641-1964 Electrical welding accessories.

Structural and Electrode Quality Steels

Development of welding as a tool for fabrication is intimately connected with the availability of not only the welding material, equipment and trained personnel, but also on the availability of steels of weldable quality.

The International Institute of Welding classifies structural steels into four qualities with notch toughness of the material as the main criterion supplemented by chemical analysis and homogeneity of the steel.

Quality A Steels — satisfy only moderate conditions and offer a certain safety against the risks of cracks and blow-holes in the weld.

Quality B Steels — are intended for use in welded structures or structural parts, not of excessive thickness subjected to normal loading conditions and having a normal safety factor in service.

Quality C and Quality D Steels — (improved notch tough qualities) are to be used for structural parts, whose design, importance and/or service conditions necessitate the risk of brittle fracture being taken into account.

While this classification is still to receive due recognition, the National Committee on steels is seriously considering its adoption.

The steels mainly used in structural fabrication are covered in three Indian Standards. IS : 226-1962 covers mild steel which is easily weldable upto a thickness of 20 mm. Above this thickness special precautions like pre-and post weld heat treatments may have to be taken, and special electrodes may be required. Steel conforming to IS 2062-1962 is fully killed and of guaranteed weldability. For thicknesses upto 28 mm, the manufacturer would certify the weldability. Beyond 28 mm thickness, the standard specifies a tentative weldability test. IS : 961-1962 deals with high tensile steel. All these steels are suitable for structures subjected to static as well as dynamic load. With the production of these steels, plastic theory which was in an experimental stage till recently is being greatly used for the design of rigid frames of buildings.

The other important standard steels are covered by IS : 2002-1962—Steel plates for boilers and IS : 3039-1965 Structural steel (shipbuilding quality). Both being weldable have helped development of welding in the fields of boiler and pressure vessels and shipbuilding industries.

Standardization at International Level

To unify the standards of various countries to facilitate mutual trade and closer collaboration the International Organization for Standardization (ISO) has been formed. India is a participating member of the Technical Committee on 'Welding' of the ISO. A number of ISO recommendations have been formulated on the subject of welding. These recommendations cover basic aspects like length and size of electrodes and filler rods, methods of testing, radiographic inspection of welds, components for resistance welding equipment etc. It is gratifying to note that most of these recommendations have been adopted either in full or in part while evolving Indian Standards on welding.

Conclusion

From the review given above it is clear that Indian Standards have played a very important role in the development of welding technology, although much remains to be done.

It would be appropriate to add that the Indian welding industry on its part has rendered very active assistance in the formulation of Indian Standards on welding and implementing them. It is hoped that the industry will give greater cooperation so that the task of standardization in the field of welding makes further progress to the satisfaction of all concerned.