

# International Institute of Welding

## —Brief Report on the work during 1978-79

(Continued)

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### Group 2

#### Commission V

This Commission deals with non-destructive and destructive tests, including related subjects of training, quality assurance and the significance of defects.

Work on the assessment of the size of defects in radiographic inspection carried out in various countries is dealt with in Doc. V-655-79. The use of Ytterbium 169 as a gamma ray source is also being studied. The preparation of a new collection of reference radiographs of welds in aluminium has not made progress because of difficulties in the collection of the necessary welded samples.

SC C is working on the ultrasonic inspection of welds in austenitic steel. Another subject concerns the interpretation and assessment of ultrasonic signals on the basis of the reflectivity diagram or other methods (doc. V-664-79).

SC E is engaged in a quantitative assessment of the measurement of crack depth by eddy-current tests. This SC has also produced a first draft of a handbook on the magnetic particle inspection of welds.

SC F which is concerned with welding defects and their significance has produced the document V-649-79 "IIW recommendation—inspection of welds when fitness-for-purpose criteria are applied—preliminary recommendation" which is recommended for publication.

The Working Group concerned with training of personnel employed in non-destructive testing has produced Doc. V-662-79 "Recommendation concerning personnel using penetrant and magnetic methods" and Doc. V-644-79 "Qualification of C level personnel—survey report".

SC D has produced Doc. V-647-79 "Investigation of the through thickness properties of steel plates for welded constructions".

Finally Commission V has prepared a survey of the colloquium held in Copenhagen in July 1977 on "the non-destructive determination of types, positions, directions and sizes of weld defects", the papers presented at which unfortunately could not be published.

#### Commission IX

For further studies in cold cracking, SC B carried out experiments dealing either with the implant method or with the simulation of the thermal cycle and stress with hydrogen loading during cooling (doc. IX-1122-79). It was possible to clarify, taking hydrogen into account, the notions of carbon equivalent and cracking parameter.

A final report on re-heat cracking was prepared (doc. IX-1137-79). Also there were several contributions attempting to clarify the role of precipitations at grain boundaries of primary austenite and that of certain trace-elements.

SC J has been entrusted with the metallurgical study of the weld metal of steel welds in liaison with Commissions II and XII ; these objectives cover reactions at the liquid state, solidification structures, solid state transformations, defects in weld metal and the correlation between the chemical composition of the weld metal and its metallurgical structure on one hand, and its mechanical properties and its resistance to corrosion on the other.

Creep and high temperature properties are being studied by a Working Group which is collecting practical data on creep, examining the residual life of assemblies and investigating the behaviour of transition joints.

SC G has completed its "Guide for the welding and weldability of C-Mn steels and C-Mn micro-alloyed quenched and tempered steels" and is looking into its publication. A work of the same kind is in preparation on the welding of reinforcing bars and on the welding of pearlite free or pearlite reduced steels.

SC F has completed its document on the classification and selection of steel for welded constructions, together with the revision of a previous document on further test to determine sensitivity to lamellar tearing. The choice of tests for the classification of steels and suitability tests for particular applications are being dealt with in liaison with Commission X.

SC H which deals with the welding of stainless steels and nickel-based steels intends to prepare recommendations on the welding of steels of various compositions and, secondly, on hot-cracking in completely austenitic alloys with a high nickel content.

A Group on non-ferrous metals, operating in liaison with the Select Committee "Aluminium and aluminium alloys", is preparing reports on cracking tests, filler metals with structural hardening and corrosion problems.

#### Commission X

A Colloquium on the practical applications of fracture mechanics was held in Bratislava in which the following topics were considered :

- Correlation between tests on specimens and the behaviour of welded structures. Assessment of case of fracture. Experimental work on failed structures.
- Application to the calculation and design of welded constructions. Specifications and standards.
- Use for the qualification of welding consumables and modes of fabrication.
- Use in rules for non-destructive testing. Specification of defects. Use in reaching the decision whether to repair or accept defects revealed at the end of construction or while in service.

An important conclusion is that there is still no general agreement on acceptable overall stress or strain limits in the presence of sharp discontinuities, even though 4-5 times yield strain can be accepted for ordinary

steel structures. There is at present no agreement either on the gauge length over which these strains should be defined.

Even though fracture mechanics have made it possible to advance knowledge and to explain causalities, its introduction into codes and specifications raises problems, especially due to the scatter of measurements in the welded zones and to the too conservative character of the design curves proposed. That is why in 1980 the Commission will resume its discussion of a resolution proposed by the French delegation not to introduce fracture mechanics into the codes.

Documents on reheat cracking (doc. X-943-79) and thermal stress relief (doc. X-933-79) appear to explain the present position in relation to these two problems. Following two problems will also be studied : (a) numerical analysis of stresses, strains and other effects caused by welding, and (b) the experimental assessment of residual stresses and strains.

#### Commission XIII

Following documents which inquire into fatigue fractures in service are recommended for publication : a superheater header (doc. XIII-865-78), a connecting rod (doc. XIII-913-79) and a conveyor shaft screw (doc. XIII-929-79). A second volume describing 33 new fracture cases has just been published, following the first one which described 65.

The Commission has also tackled the influence of thermal cutting on fatigue strength, both in the case of oxygen cutting (doc. XIII-919-79) and of plasma cutting (doc. XIII-922-79).

Further, the Commission is carrying on with its work on improving the fatigue strength of welded assemblies, on the fatigue of tubular structures and on the statistical analysis of fatigue test results. In liaison with Commission XV a joint Working Group is preparing a recommendation on the use of fatigue test results in design.

#### Group 3

#### Commission XI

SC A which deals with 'Weld details' has completed the revision of doc. IIW 237-66 "Recommended weld connections for pressure vessels" and IIW-146-64 "Recommended welded connections for pipework" and these are expected to be recommended for publication

at the 1980 Assembly. The future programme will cover repairs of pressure vessels by welding.

SC B which deals with 'Stresses in pressure vessels' has completed a statement on weld efficiency. In this connection, the SC considers that the lowering of the weld efficiency should not be considered as a guarantee of safety as regards the occurrence of possible defects and as having a relationship with the amount of non-destructive testing. A final text will be proposed to the Commission.

In addition, the Commission has considered doc. XI-357-79 on the fabrication of cylindrical tanks by the method of coiling and doc. XI-361-79 on the brittle fracture of a gas pipeline, starting from a lack of fusion in a helical weld. An analysis of this occurrence showed that there was a good measure of agreement with the fracture mechanics conclusions.

The Commission is preparing a colloquium on "layered wall vessels and tubes for high pressures applications" which will cover welding aspects, design aspects, inspection and testing, service experience and future developments.

#### Commission XV

This Commission is divided as follows :

- SC A—Calculation of welded joints submitted to static loading.
- SC C—Design for welding.
- SC D—Aluminium
- SC E—Welded joints in tubular structures
- Working Group XIII/XV—Calculation of welded joints submitted to dynamic loads.

The Commission has approved doc. XV-439-79 "Recommended practice for testing the strength of fillet welds in structural steels and aluminium alloys". Work on design for welding is continuing and a recommendation is being prepared which will include, in particular, recommendations to prevent lamellar tearing. An interesting document is XV-440-79 "Proposal for increasing the ultimate load of butt-welded joints in aluminium alloys". Document XV-436-79 "Design rules for predominantly statically loaded welded joints in circular hollow sections" was discussed and is likely

to be finished in 1980. An extension of this work to cover rectangular hollow sections and high strength steels has been taken up.

WG XIII/XV has prepared a draft on design rules for cyclically loaded welded structures and it has also begun the study of the best analysis method for fatigue tests results.

#### Commission XVI

The programme includes :

- 1 Testing methods, 2. Optimisation of welding variables, 3. Adhesive bonding of metals and plastics, 4. Ultrasonic welding, 5. Electric sleeve welding of plastic pipes, 6. Bibliography concerning welding of plastics and adhesive bonding, 7. Joining techniques of plastic pipes, 8. Terminology (in liaison with Commission VI), 9. Collaboration with ISO/TC 44 (welding) and ISO/TC 138 (plastics).

Following documents have been recommended for publication :

- XVI-348-79 "Testing of semi-finished products and weld joints in thermoplastics"
- XVI-349-79 "Welding of thermoplastics machines and equipment for hot gas welding"
- XVI-350-79 "A digitally controlled welding machine for plastic pipes"

#### Group 4

#### Commission VI

A section on "Special welding processes" will be shortly published. The revision of the section "Gas Welding" issued in 1953 is nearly completed. In response to a request from ISO/TC 44, it has been decided to compile a list of the main welding processes with their definitions. This will be based on the standard ISO 4063 "List of welding, brazing, braze welding and soldering processes for metals, for symbolic representation on drawings".

The revision of the "General terms" section is under way, while the preparation of the section "Adhesive bonding of metals and plastics" has just begun. Sections on "Arc welding" and "Resistance welding" will also be revised in the future.

## Commission VIII

This Commission is divided as follows :

- WG A—revision of the handbook on health and safety
- WG B—ventilation
- WG C—medical and industrial health problems in welding
- WG D—underwater welding and cutting
- WG E—statistics and prevention of accidents

The French text of "The handbook on health and safety in welding" will be soon published. The English version is under revision. Work of WGC is of prime importance. Following four documents are recommended for publication :

- VIII-823-79 "Health of welders, those in similar trades, their assistants and neighbourhood workers"
- VIII-839-79 "Formation of nitric oxides in gas welding—measures for the prevention of health injuries"

—VIII-843-79 "Effects of fibrous active carbon filter against noxious weld gases"

—VIII-815-79 "Measurement of lung contamination among mild steel and stainless steel welders"

Five Czechoslovak documents (doc. VIII-808 to 813-79) describe and illustrate examples of accidents by fire, explosion or electric shock involving human beings or animals.

## Commission XIV

The Commission is presently collecting information on the training of welding engineers. In this connection, doc. XIV-383-78 "Instruction, examination and assessment of welders and welding engineers" is recommended for publication.

With regard to the training of welders, doc. XIV-380-79 containing recommendations relating to the qualification of welders has been forwarded to the ISO/TC 44. Further, doc. XIV-393-79 has been recommended for transmission to the ISO as appendix 1 to the above. Other appendices will follow, as they are finished. A syllabus for the theoretical training of welders will also be produced.