**TECHNICAL DATA SHEET**

**on**

**GAS PRESSURE WELDING**

**By Assetsu India Pvt. Ltd.**

**Mumbai**



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**Assetsu India Pvt. Ltd.**

**Gas Pressure Welding (GPW) Technical Data Sheet –**

1. **Introduction:**

**Overview**:

Gas Pressure Welding (GPW) is a metal joining process used primarily in construction and infrastructure projects to create strong, reliable connections between steel reinforcement bars (rebars).

This process involves a mixture of two gases to create a temperature or over 1200°C, this temperature is used to achieve a semi-molten condition on clean rebar mating surfaces, post this stage, controlled hydraulic pressure is applied on the rebars to create a molecular bonding between the rebar surfaces.

**Specifications**:

Materials**:**

* + Primarily used for welding steel rebars in construction.
  + Suitable for various grades of steel, typically reinforcing bars with specified mechanical properties.

Process Type:

* + Fusion welding technique utilizing heat and pressure to create a metallurgical bond between surfaces.

Welding Equipment:

* + Gas-fuelled zone burner, hydraulic pump & specialized equipment capable of precise temperature control and precise pressure application.
  + Fixtures or clamping mechanisms to hold and align the components during welding. (welding base)

Surface Preparation:

* + Make a fresh 90˚ cut right before welding. The area of welding should not have any dirt, contaminants or oxidisation which can hamper the quality of the weld.

Temperature & Pressure Application:

* + Controlled heating to reach the semi-molten state at the ends of the rebars without causing overheating or distortion.
  + Mechanisms or tools for applying controlled & uniform pressure to the molten ends of the rebars during the welding process.

Quality Control & Inspection:

* + Testing procedures including tensile, bend, visual, and impact tests to assess weld strength and reliability.

Safety Measures:

* + Adequate safety protocols & PPE for handling high temperatures, gas-fuelled equipment, and welding operations.

**Benefits**:

Structural Integrity:

* + - Creates strong, reliable metallurgical bonding crucial for the structural integrity of concrete structures.

Efficiency:

* + - Space-efficient and doesn’t extend the length of rebars, optimizing construction space.

Cost-effectiveness:

* + - Considerable savings in labour, material & scrap costs compared to alternative methods.

Strength:

* + - These joints display higher tensile and compression strength due to metallurgical bonding.

Reliability:

* + - Provides reliable and durable connections.

Speed:

* + - Can expedite construction timelines with quick execution.

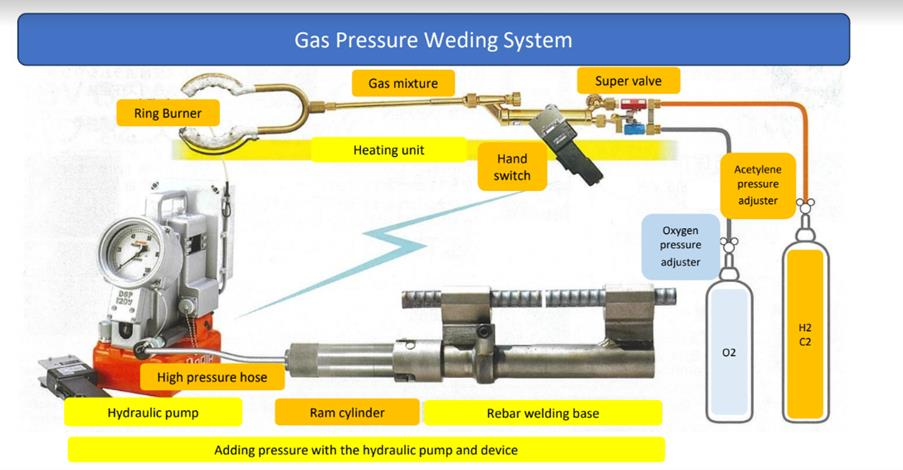
Congestion:

* + - Prevents congestion during cementation due to less surface area usage.

**Construction Applications:**

* + Buildings: Skyscrapers, residential structures, industrial complexes, etc.
  + Bridges and Infrastructure: Highway overpasses, tunnels, dams, metro, railway infrastructure.
  + Industrial Structures: Factories, warehouses, power plants, etc.

1. **Product Composition & Technology**



1. Hydraulic Pump: A compact and portable hydraulic pressure pump to apply controlled pressure to the heated metal surfaces during the welding process.
2. Ram Cylinder: Responsible for applying controlled pressure which creates strong bonds.
3. Rebar welding base: The rebar welding base serves as a fixture or platform to securely hold and align the steel reinforcement bars (rebars) during the welding process. Its

primary purpose is to provide stability, alignment, and support for the rebars being welded.

1. Gas Mixture Tube & Super Valve: They are crucial to control & regulate the flow &

mixture of gases used in the welding process. It helps the welders ensure the creation & adjustment of appropriate flame needed for an effective welding.

1. Zone Burner: The ring burner emits a circular, evenly distributed flame, ensuring

consistent heating along the circumference of the metal components to be welded. It helps ensures precise temperature to maintain consistency and quality in the welds.

1. Gases: The gas pressure welding uses a mixture of gases. Together these gases create a high-temperature flame used to heat and melt the ends of metal
2. Other accessories: Other accessories such as couplers, bolts, wrenches, gas hoses, etc, are all built precisely for this technology keeping in mind the high temperature and ease of use factors.
3. **Application**
   * **Procedure of use**:
4. Make a clean, 90˚ angle cut at the desired size on the rebars.
5. Adjust the rebar on the rebar welding base and tighten grip so it says in position.
6. Ignite the torch and adjust the flame to the appropriate size and temperature required for the metal being welded.
7. Heat the ends of the metal components until they reach a molten state.
8. Apply controlled pressure using a ram cylinder and hydraulic pump to forge them together.
9. Allow the welded joint to cool naturally.
10. Inspect the weld for quality, ensuring proper fusion and no defects. The welded bulge should be 1.4times the diameter of the rebar.

* **Inspection**

For quality control testing of welded joints:

1. **Tensile bend test** – Tests the material joints strength when subjected to pulling

forces. GPW performs very well under tensile testing, where the rebar fractures from the rebar and not from the welded joint.

1. **Bend test** – Bend test assesses a material’s ductility and resistance to fracture when bent. It identifies any tendencies to crack or fail when stressed. Useful for testing joints outcome during seismic movement as well.
2. **Visual test –** Visual tests are essential post every joint to ensure a successful bonding. The joint should not be melted and be aligned.

* **Usage in the construction industry**

Gas pressure Welding finds a significant usage in the construction industry, particularly in reinforcing steel structures due to its numerous advantages.

With the growing construction industry and the pressure of sustainable and good

quality builds on engineers and builders, GPW is a boon which provides great quality reassurance while also increasing your savings considerably.

However, while GPW offers numerous benefits, it requires skilled labour and adherence to proper procedures and safety protocols for effective implementation. When used

correctly, GPW is a valuable technique in the construction industry, ensuring robust connections in reinforced concrete structures.

1. **Advantages**
   1. **Rebar Connection:** GPW is extensively used to join steel reinforcement bars (rebars) in reinforced concrete structures, ensuring sturdy and reliable connections between bars while allowing smooth concrete flow.
   2. **Structural Integrity:** Welded connections through GPW contribute to the structural integrity of buildings, bridges, dams, and other concrete structures by creating strong, durable joints.
   3. **Space Efficiency:** Unlike methods like overlapping, GPW doesn’t extend the length of rebars, making it more space-efficient in construction projects where space optimization is critical.
   4. **Time Efficiency**: GPW can expedite construction timelines due to its relatively quick execution, potentially speeding up project completion.
   5. **Cost Savings:** By reducing material usage and labour hours, GPW can contribute to significant cost savings in construction projects.
   6. **Reliability**: Properly executed GPW welds offer long-term reliability, enhancing the durability and longevity of structures.
   7. **Versatility**: GPW can be employed in various weather conditions and environments, making it adaptable for different construction scenarios.
   8. **Tests**: as compared to current technologies, GPW joints perform very well in Bend tests compression test and tensile strength test. It shows reliability and structural integrity of the weld.
2. **Considerations**

While mentioning that GPW benefits, it also important to consider some factors before you begin your journey with this technology.

* 1. **Skilled labour** – A good technology needs a good master and therefore basic training in the technology is highly recommended to make the most out of this method.
  2. **Safety measure** – While operating at high temperatures and in general at construction sites, basic safety measures are needed to avoid mishaps
  3. **Quality control** – Correct technique is required in the said technology, therefore to

assure that your welder is performing well and your structure is strong, timely tests of quality are recommended practice.

* 1. **Technology handling** – Misuse of the technology by untrained professionals can be harmful, both commercially and physically.
  2. **Rebar preparation**- To ensure a strong weld, the rebar needs to be cleanly cut and attached on to the rebar holder properly to make a strong stable joint
  3. **Temperature control** – Since inflammable gases are being used, control needs to be taken of temperatures when in operation.

This being said, all the above points are covered in a good training. It is easy to use but yet requires some basic skills just like any other new technology which is adopted.

1. **Industry standards & compliances**

For mass production of welded joints, GPW is the most suitable technology as it is easy to adapt and use, has numerous benefits over lapping and coupling and is economical.

**What does our IS codes say?**

* + - IS 9417:2018 [Clause 10.1.1] High strength deformed steel bars shall be either butt welded or lap welded. Butt welding may be carried out either by flash butt, gas

pressure or by shielded metal arc welding process.

* + - IS 9417:2018 [Annex C] Annex C gives more information on recommendations in regards to the preparation for welding procedure and equipment’s.
    - IS 2751:1979 [Clause 02.b] ..use of gas pressure welding processes has been permitted.
    - As per IS 456:2000 [Clause 12.4] Welded joints or mechanical connections in

reinforcement may be used but tests shall be made to prove that the joints are of the full strength of bars connected. Welding of reinforcements shall be done in

accordance with the recommendations of IS 9417:2018.

* + - As per SP: 34 [APPENDIX A,] Welded joints are permitted in reinforcement (mild steel and deformed bars).
    - CPWD Volume I 2009 [Clause 5.3.2] Wherever facility for electric arc welding or gas pressure welding is available, welding of bars hall be done in lieu of overlap. The location and type of welding shall be got approved by the engineer-in-charge.

Welding shall be done as per IS 2751 & IS 9417.

\*BIS & CPWD documents attached below\*

1. **GPW HISTORY IN India**

As construction methods evolve and engineering standards develop, GPW continues to play a vital role in reinforcing steel structures and providing durable connections in various

construction projects across the country.

Majorly construction companies in the seismic movement active zone, where the first to adopt this technology.

* A Country Report on Splicing of Rebars by Mr.P.B. Vijay, Mr. C.S. Viswanatha & Mr. S.K. Kaushik was presented at the First International Conference on Splices of

Reinforcement. The conference was held at Kanagawa, Japan in October 2022 where the team presented the report and represented India on this platform provided by the

Japan Pressure Welding Society.

\*report attached below\*

* + CASE STUDY OF ATS INFRASTRUCTURE: NOIDA

Noida based infrastructure company ATS has been successfully using the Gas Pressure Welding system since the past 10 years.

They have seen good use and benefit from this technology and have been one of the first few companies to adopt newer, better technology.

In the last 10 years ATS has used GPW in several of their projects have been finding continuous use since a very long time.

ATS director Mr. Getambar Anand published an article in CREDAI Issue January February March 2010, it stated the benefit his company derives from GPW and how it is an easy to

use, economical and feasible in all practical working sites. The article also mentions the huge savings builders can achieve with effective waste management on steel consumption when GPW is used.

\*article attached below\*

1. **CONCLUSION**

Gas pressure welding though old, is a technology of the future. Its is something that

provides benefits from all aspects of work and over a period of time needs to be adapted by all builders, engineers, contractors and professionals alike. GPW's historical presence and

continued use emphasize its enduring importance in reinforcing steel structures and contributing to the safety and stability of construction projects.

This technology is set up to provide a first movers benefit and despite potential

technological advancements, GPW's consistency and effectiveness in creating durable welds make it a valuable technique in the construction industry.

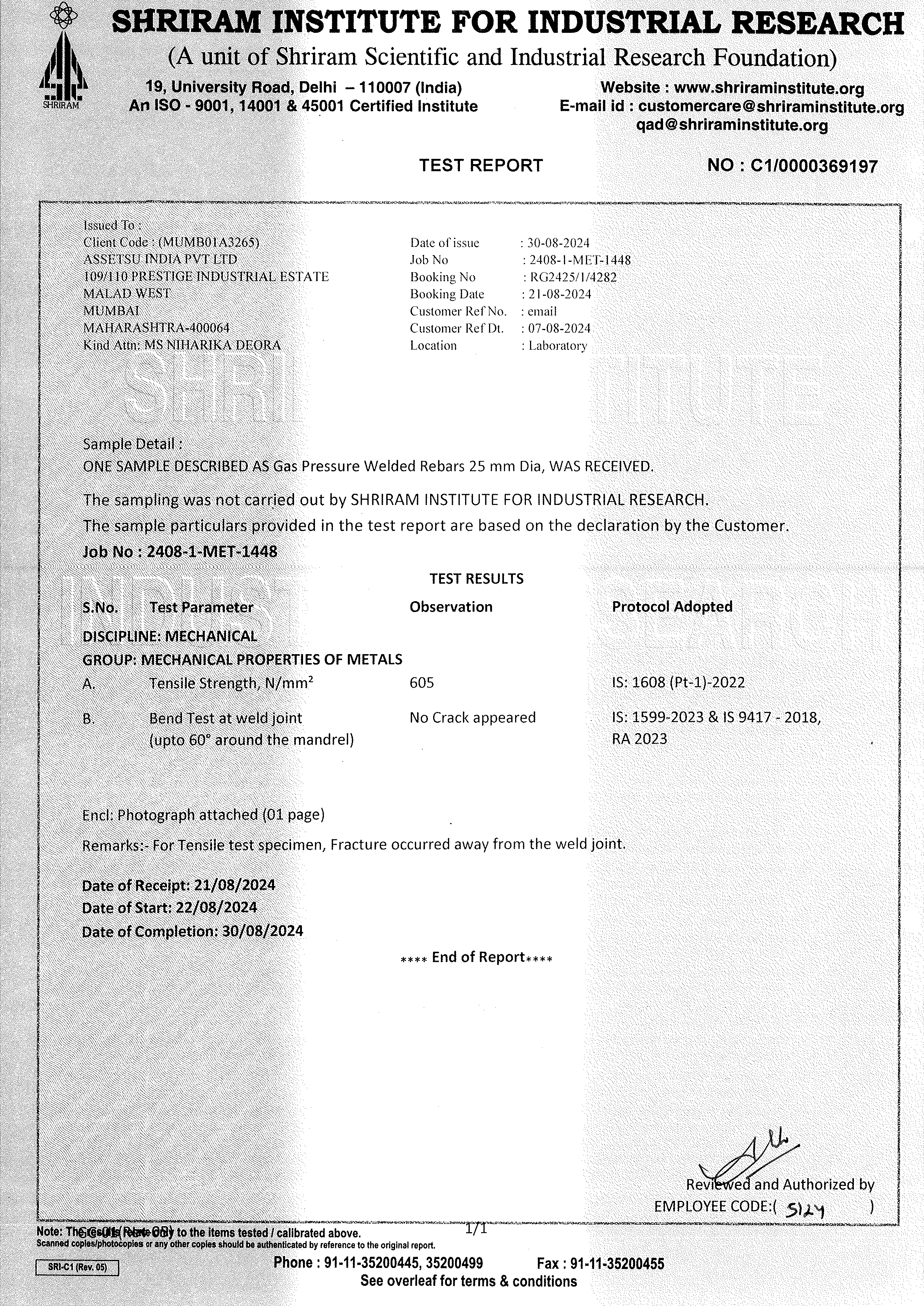
Its use in buildings, bridges, dams, and infrastructure projects underscores its role in

ensuring structural integrity across various construction applications. GPW ensures strong and dependable connections between rebars, critical for the stability and longevity of

concrete structures.

Building a structure starts from building strong foundations. Let’s build India’s new infrastructure with strong foundations and new technology.

1. **ATTACHMENTS**
   * Test report for Tensile test & Bend test
   * IS 9417:2018 – Welding of High Strength Steel Bars for Reinforced Concrete Construction - Recommendations
   * IS 2751:1979 – Code of Practice for Welding of Mild Steel Plain and Deformed Bars for Reinforced Concrete Construction
   * IS 456:2000 – Plain and Reinforced Concrete – Code of Practice
   * Extracted pages from: CPWD Specification (VOL. 1) 2009.
   * Splicing Of Rebars: A Country Report by P.B. Vijay.
   * Article by Mr. Getambar Anand, ATS in CREDAI Issue 2010.



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***Indian Standard***

**IS 9417 : 2018**

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**Welding of High Strength Steel Bars for Reinforced Concrete Construction —**

**Recommendations**

*( Second Revision )*

ICS 25.160:77.140.15

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### *Indian Standard*

IS 9417 : 2018

## WELDING OF HIGH STRENGTH STEEL BARS FOR REINFORCED CONCRETE CONSTRUCTION — RECOMMENDATIONS

( Second Revision )

1. SCOPE

This standard lays down recommendations for welding high strength steel bars conforming to grades Fe 415, Fe 415D, Fe 500 and Fe 500D of IS 1786 by flash butt welding, shielded metal arc welding, gas pressure welding and gas metal arc welding (GMAW) using CO2.

1. REFERENCES

The standards listed in Annex A contain provisions which, through reference in this text, constitute provision of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards listed in Annex A.

1. TERMINOLOGY

For the purpose of this standard, definitions given in IS 812 shall apply.

1. PLANS AND DRAWING

Plans and drawing for welding reinforced steel bars shall be prepared in accordance with SP 46.

1. SYMBOLS

Symbols for welding used in plans and shop drawings shall conform to IS 813.

1. WELDING EQUIPMENT AND ACCESSORIES

Welding equipment and accessories used in welding of steel bars for concrete reinforcement shall conform to the requirements of the appropriate Indian Standards, where available. Where an Indian Standard is not available, equipment and accessories shall be of the best available quality. Their capacity shall be adequate for the welding procedure. A general guidance for selection of equipment and accessories is included in Annex B.

1. PARENT METAL

The parent metal shall be of guaranteed weldable quality of steel conforming to IS 1786.

1. SAFETY AND HEALTH REQUIREMENTS

Safety and health requirements as prescribed in IS 818 shall be applicable. Fire precautions shall be as given in IS 3016.

1. ELECTRODES

Electrodes used shall conform to IS 814.

1. WELDING PROCESSES AND PROCEDURES
   1. General
      1. High strength deformed steel bars shall be either butt welded or lap welded. Butt welding may be carried out either by flash butt, gas pressure or by shielded metal arc welding process. Lap welding may be carried out either by shielded metal arc welding process or by gas metal arc welding (GMAW) using CO2.

10.1.2 Bars of unequal diameter may be welded. However, in case of butt welding, the difference in diameter of bars shall not exceed 5 mm. Where unequal diameter bars are welded, the dimension ‘d’ mentioned in this standard refers to diameter of the smaller bar.

10.1.3 The surface of the ends of the bars to be welded shall be clean and free from rust, paint, grease and/or other contaminants which are likely to affect the quality of weld.

* 1. Flash Butt Welding of High Strength Deformed Steel Bars
     1. Flash butt welding may be adopted if a large number of welding has to be done at the same place and when the electric supply is available of the required capacity in respect of the cross-sectional area of the maximum size of the bar to be welded.
     2. Procedure
        1. The ends of the bars to be welded should be placed in proper alignment in clamps so that bent or eccentric joints do not result. The clamps should be cleaned before each welding operation to avoid current loss and to eliminate harmful notches or grooves due to burning in of spots of arcing.
        2. The bar ends shall be uniformly pushed against

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IS 9417 : 2018

introduced in the bars during the process of welding. The joints may not be out of alignment by more than 25 percent of the thickness of the thinner material for material up to and including 12 mm thick, or by more than 3 mm for thicker material.

* + 1. Electrode
       1. Welding electrodes with flux covering of rutile

(R) or basic (B) type as per IS 814 are recommended for better results depending on the size of the bar to be welded. Storage of the latter type and their drying immediately prior to use must be strictly in accordance with the recommendation of the electrode manufacturer.

* + - 1. The size of electrodes depends upon the position of the bead and thickness of the bar to be welded. The root runs should be made with electrodes of size not exceeding 2.5 mm. For successive beads, the size of the electrodes should be progressively increased so that in the top bead, the electrode size does not generally exceed 3.15 mm for 20 mm bars and 5 mm for 40 mm bars.
      2. Concentration of heat shall be avoided by proper welding sequence and manipulation of electrodes.
    1. Procedure
       1. The sequence of welding beads is shown in Fig. 2. The runs 1 to 4 are made in the position of welding best suited for the quality of the weld. Besides the interruption in welding required for cleaning of each bead, a pause shall be made after every second bead and the bar is allowed to cool. The temperature of the bars at a distance of about one bar diameter from the

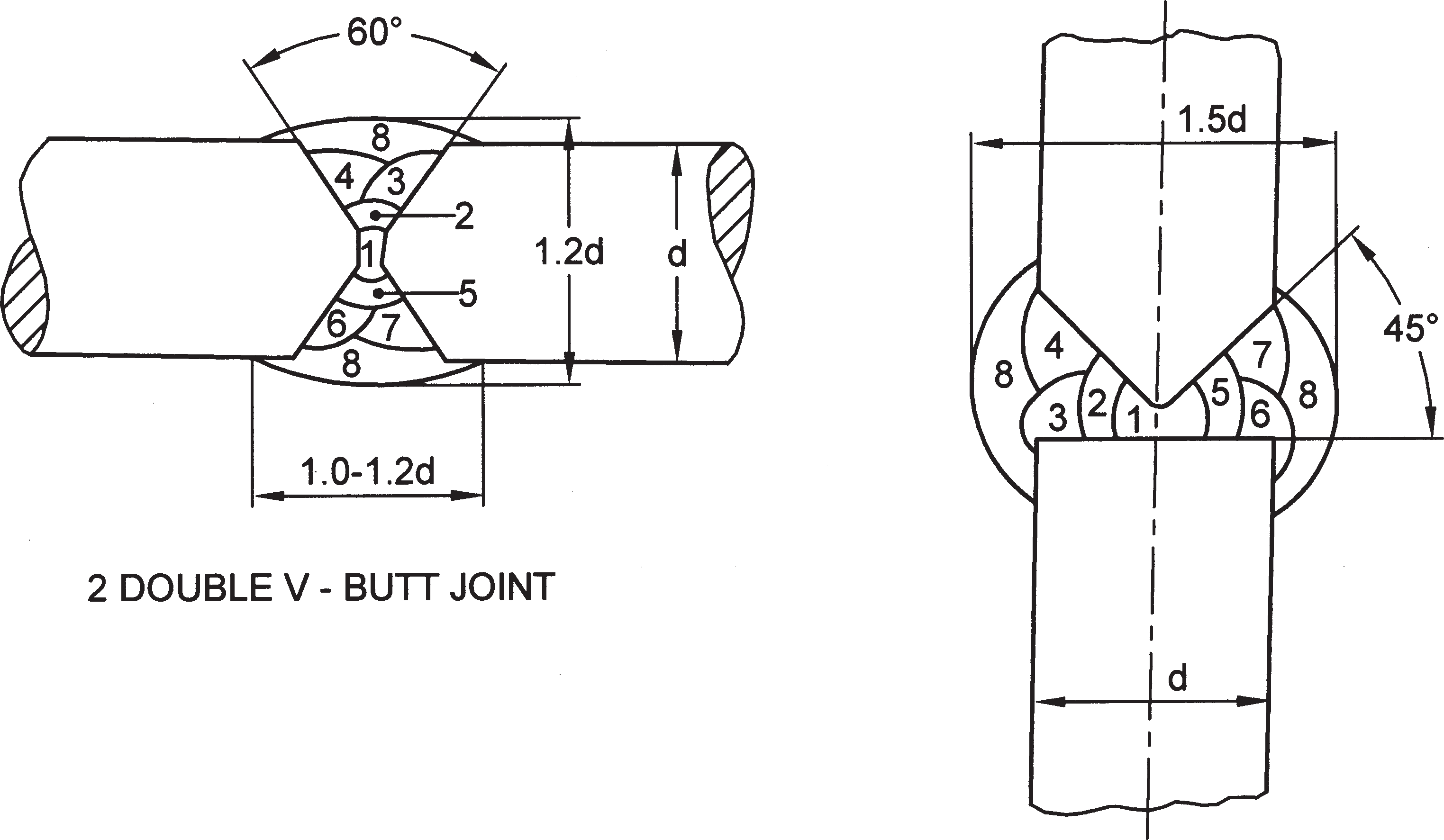
joints shall not exceed 300 °C immediately after the bead is made. Before commencing the next bead, the temperature shall not exceed 250 °C. The temperature may be checked approximately by using temperature indicating crayons. However, in the absence of temperature indicating devices, the bar may be allowed to cool down to hand hot temperature before the next bead is deposited.

After completing bead 4, the bars are turned through 180° and the beads 5 to 7 are made in the same manner as described above. The top bead 8 is deposited as the joint is continuously rotated and the size of the reinforcement should be approximately as indicated in Fig. 2.

* + - 1. In the case of non-rotatable bars, the beads 1 to 4 should be made as explained in 10.3.4.1 The welder then moves to the other side and beads 5 to 7 are similarly made. It is difficult to deposit a uniform top bead for non-rotatable bars and it may be necessary to make two or more separate annular runs so that the joint is approximately axisymmetric and has sufficient reinforcement as shown in Fig. 2.

10.4 Butt Welding by Gas Pressure Welding Process

Gas pressure welding is basically a hot forging process of joining the two bars end-end. The bar ends are heated by a multi-nozzle burner using oxy-acetylene flame and fused by forcing the two bar ends against each other under pressure to effect a solid phase welded joint. Annex C gives more information on recommendations in regards to the preparation for welding procedure and equipment.



2A DOUBLE V-BUTT JOINT 2B K-JOINT

FIG. 2 SEQUENCE OF WELDING

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ANNEX C

(Clause 10.4)

GAS PRESSURE WELDING

* 1. GAS PRESSURE WELDING PROCESS

The gas pressure welding process may be used for butt welding of reinforcing bars.

C-1.1 Preparation for Welding

C-1.1.1 The ends of bars and the extreme ends of new bars shall be cut by shearing or machining to make the face approximately normal to the axis of the bar. Care shall be taken to ensure that the bar ends do not twist while shearing.

C-1.1.2 Rust, oil, paint, cement paste and any other coating over the bar-ends shall be removed and the surfaces to be welded shall be finished as flat as possible.

C-1.2 Procedure

C-1.2.1 Bars are clamped securely in the clamping unit with no misalignment keeping the gap between the bar ends less than 3 mm.

C-1.2.2 To begin with, the bar ends are heated by a reducing flame to avoid any oxide formation. The flame shall be directed at the joint and the burner shall be rotated to ensure uniform heating of the bar ends. On sufficient heating, the gap between the bars ends shall be closed by the application of axial pressure (preliminary or first stage pressurization).

C-1.2.3 After preliminary pressurization and complete closing of the gap, the bar ends shall be heated by a neutral flame. The heating shall be done for an appropriate period ensuring that the bar ends do not melt.

C-1.2.4 On sufficient heating of the bar ends, appropriate axial pressure (final or second stage

pressurization) is applied so that the bulge at the weld interface is about 1.4 times the bar diameter. Heating shall be stopped at this stage. However, pressure application shall be maintained for some time even after the flame is put off.

C-1.2.5 The bars shall be unclamped after the glow of the heated area vanishes.

C-1.2.6 In case the flame dies out during heating, the affected area shall be cut off and the welding procedure begun afresh.

* 1. GAS PRESSURE WELDING EQUIPMENT

C-2.1 The equipment for gas pressure welding comprises of,

* + 1. oxygen and acetylene gas cylinders with regulating values, etc;
    2. multi-nozzle burner;
    3. clamping unit; and
    4. pressurizer.

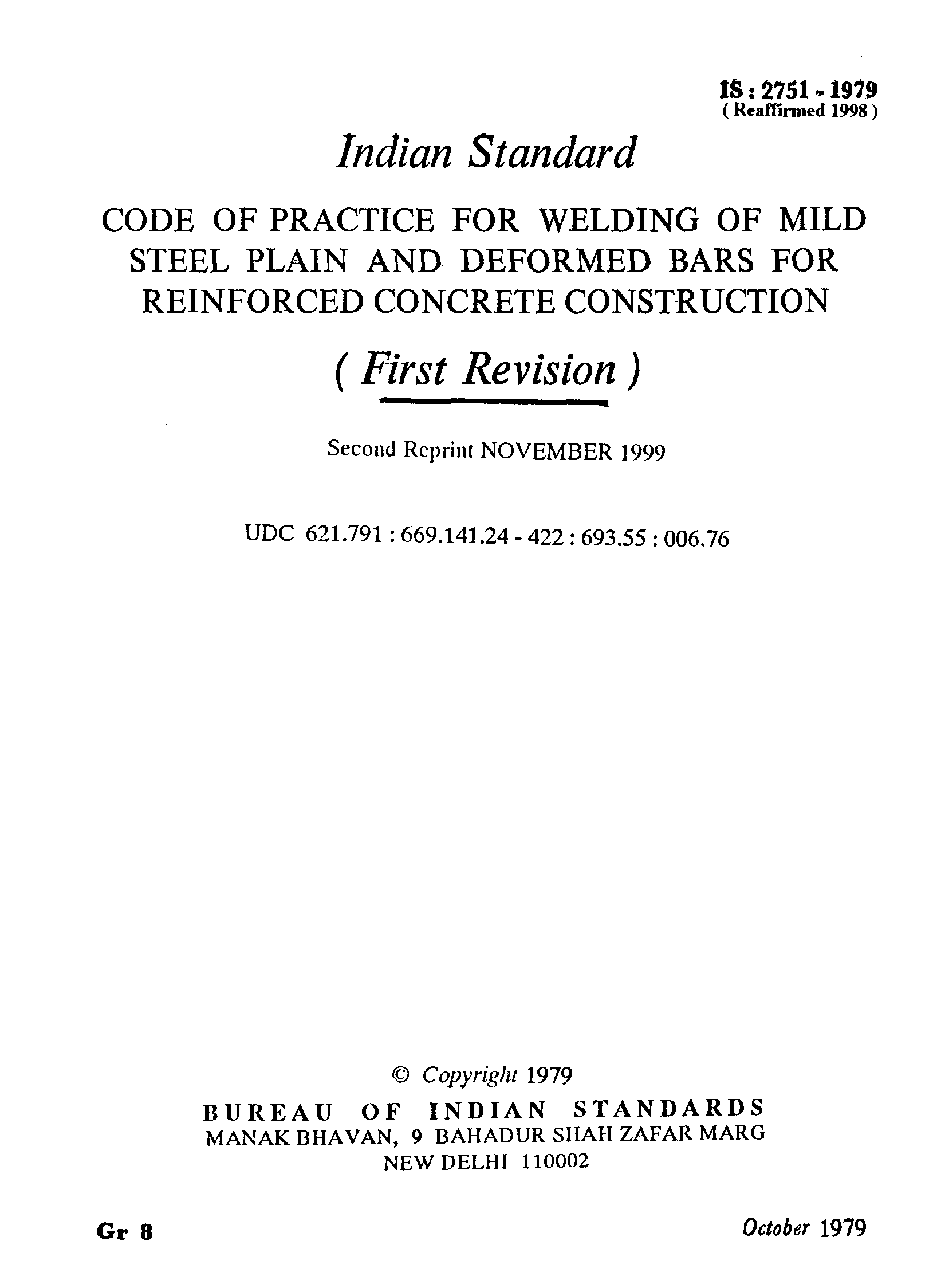
C-2.1.1 The burner consists of a blow pipe with four or more nozzles. The nozzles shall be so arranged to ensure uniform heating of the bar surface. The burner shall provide stable flame during heating and the heating capacity shall be appropriate to the size of the bar.

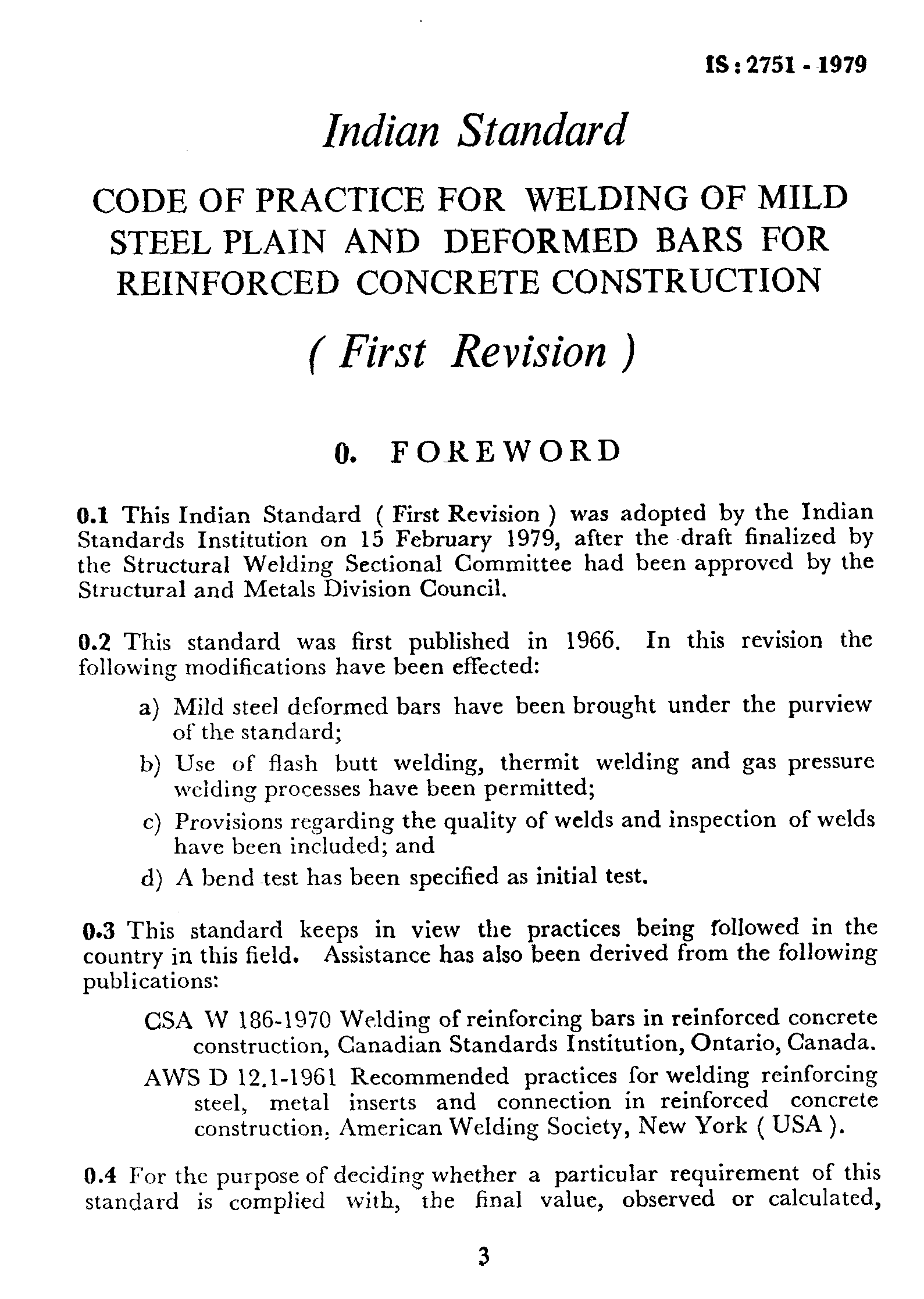
C-2.1.2 The clamping unit shall grip the bars well, be easy to handle, capable of being used in horizontal or vertical position of welding, and have such mechanism that no misalignment develops at the welded portion.

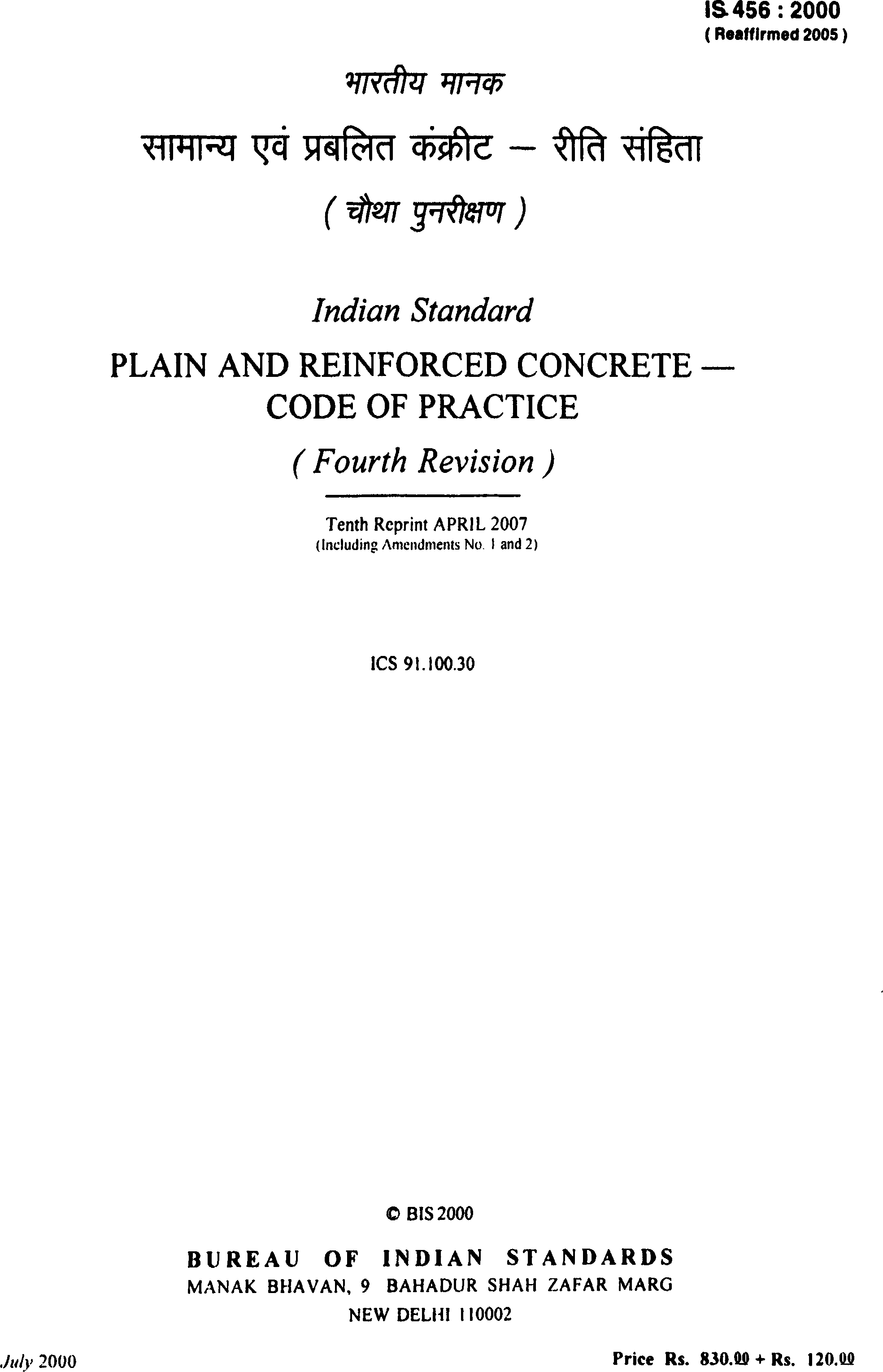
C-2.1.3 Pressurizer shall be either hydraulic or mechanical and may be either manually operated or electrically driven. The pressurizer shall be capable of maintaining uniform axial pressure

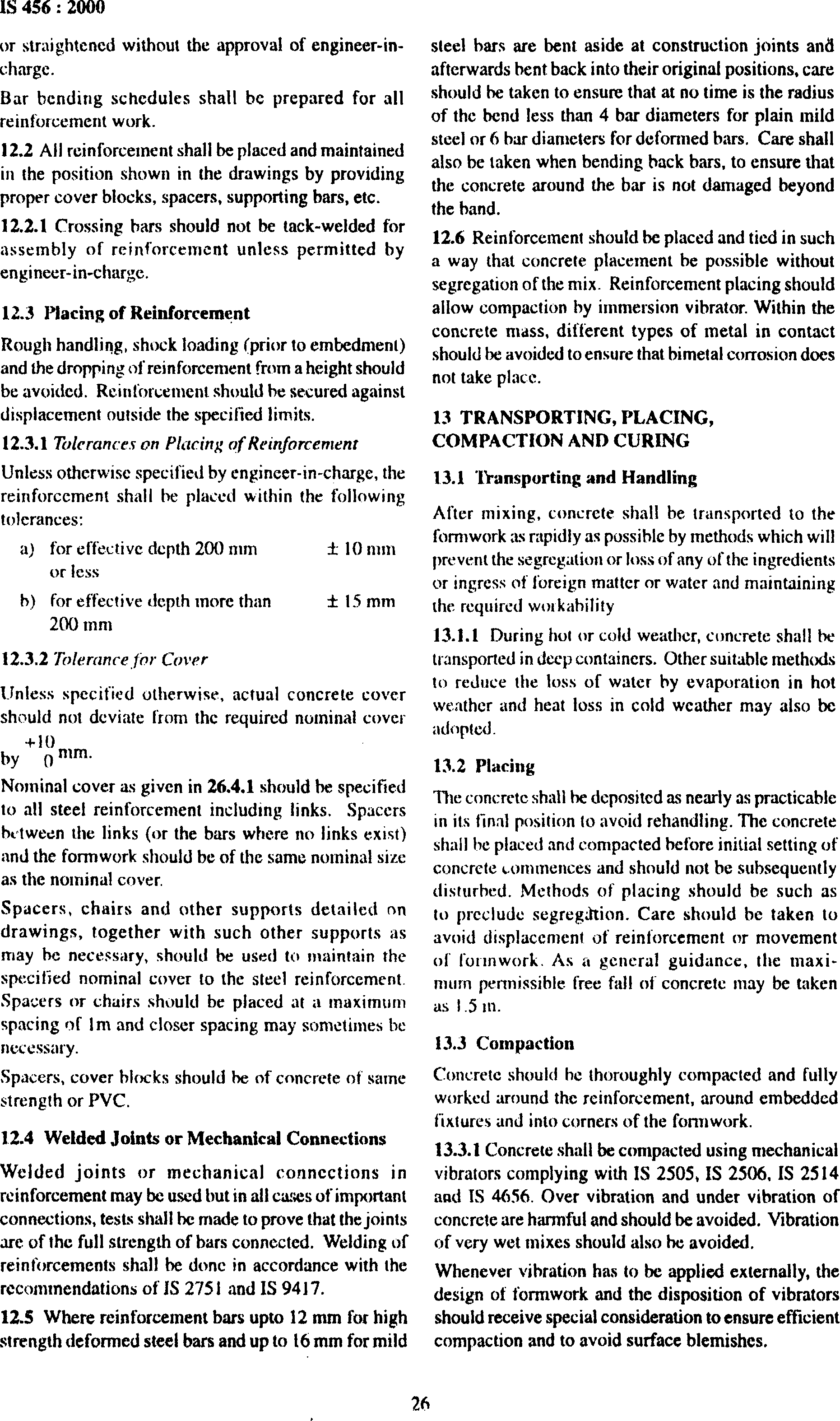
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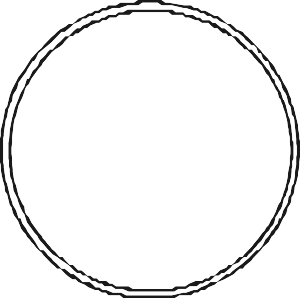
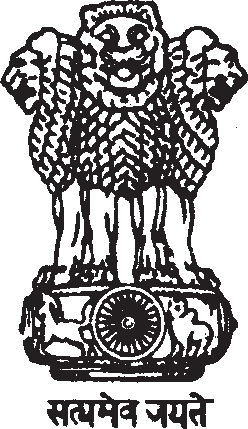
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# GOVERNMENT OF INDIA CENTRAL PUBLIC WORKS DEPARTMENT

**CPWD SPECIFICATIONS**

**(VOL. 1)**

**2009**

**PUBLISHED BY**

**DIRECTOR GENERAL OF WORKS, CPWD, NIRMAN BHAWAN, NEW DELHI**

#### REINFORCEMENTS

* + 1. **General Requirements**

Steel conforming to para 5.1.3 for reinforcement shall be clear and free from loose mill scales, dust, loose rust, coats of paints, oil or other coating which may destroy or reduce bond. It shall be stored in such a way as to avoid distortion and to prevent deterioration and corrosion. Prior to assembly of reinforcement on no account any oily substance shall be used for removing the rust.

* + - 1. ***Assembly of Reinforcement :*** Bars shall be bent correctly and accurately to the size and shape as shown in the detailed drawing or as directed by Engineer-in-Charge. Preferably bars of full length shall be used. Necessary cutting and straightening is also included. Overlapping of bars, where necessary shall be done as directed by the Engineer-in-Charge. The overlapping bars shall not touch each other and these shall be kept apart with concrete between them by 25mm or 11/4 times the maximum size of the coarse aggregate whichever is greater. But where this is not possible, the overlapping bars shall be bound together at intervals not exceeding twice the dia. of such bars with two strands annealed steel wire of 0.90 mm to 1.6 mm twisted tight. The overlaps/ splices shall be staggered as per directions of the Engineer-in-Charge. But in no case the overlapping shall be provided in more than 50% of cross sectional area at one section.
      2. ***Bonds and Hooks Forming End Anchorages:*** Reinforcement shall be bent and fixed in accordance with procedure specified in IS 2502, code of practice of bending and fixing of bars for concrete reinforcement. The details of bends and hooks are shown below for guidance.
         1. *U-Type Hook*

In case of mild steel plain bars standard U type hook shall be provided by bending ends of rod into semicircular hooks having clear diameter equal to four times the diameter of the bar.

**Note:** In case of work in seismic zone, the size of hooks at the end of the rod shall be eight times the diameter of bar or as given in the structural drawings.

* + - * 1. *Bends*

Bend forming anchorage to a M.S. plain bar shall be bent with and internal radius equal to two times the diameter of the bar with a minimum length beyond the bend equal to four times the diameter of the bar.

* + - 1. ***Anchoring Bars in Tension :*** Deformed bars may be used without end anchorages provided, development length equipment is satisfied. Hooks should normally be provided for plain bars in tension. Development length of bars will be determined as per IS: 456.
      2. ***Anchoring Bars in Compression :*** The anchorage length of straight bar in compression shall be equal to the ‘Development length’ of bars in compression as specified in IS: 456. The projected length of hooks, bend and straight lengths beyond bend, if provided for a bar in compression, shall be considered for development length.
      3. ***Binders, stirrups, links etc. :*** In case of binders, stirrups, links etc. the straight portion beyond the curve at the end shall be not less than eight times and nominal size of bar.

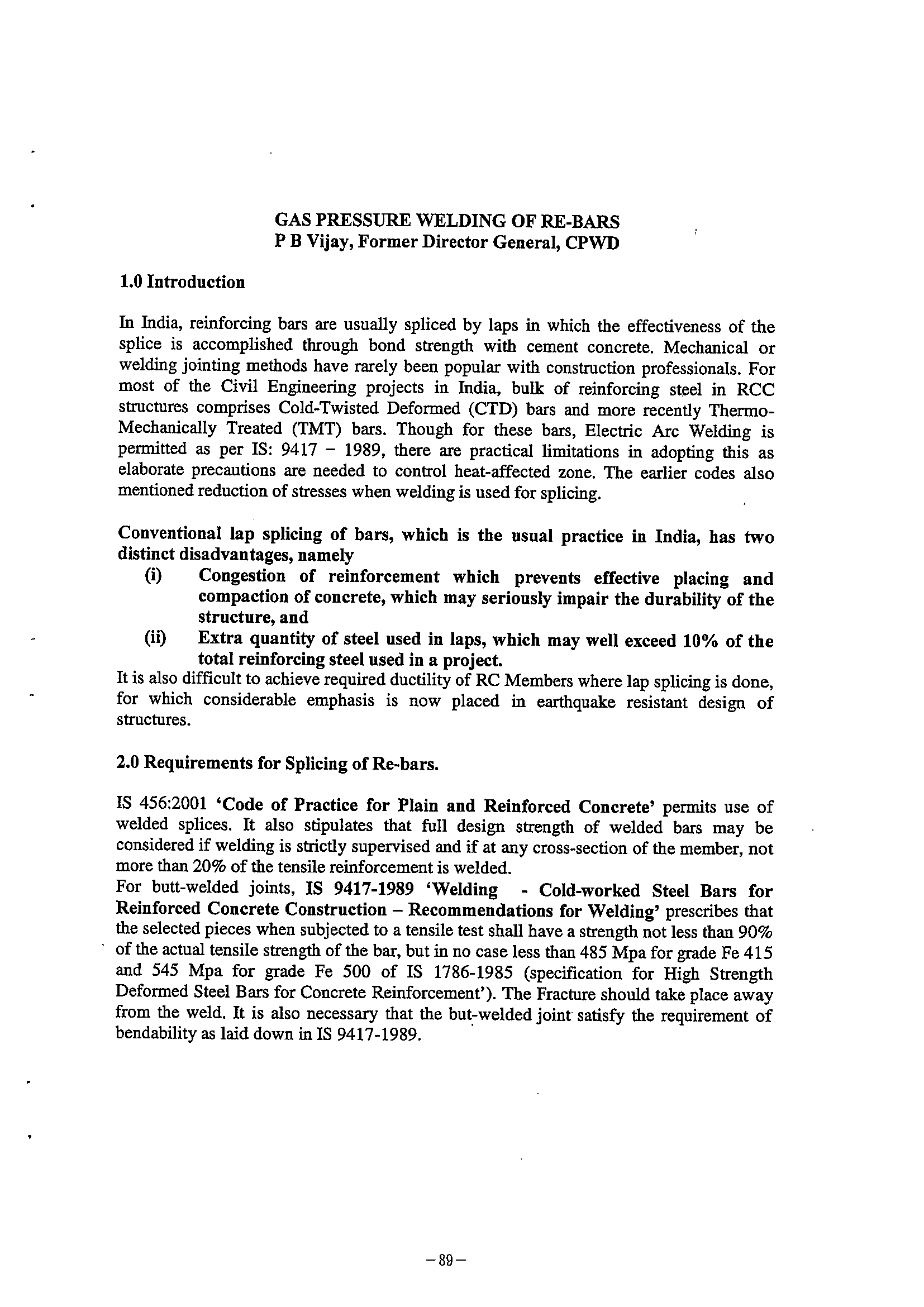
#### Welding of Bars

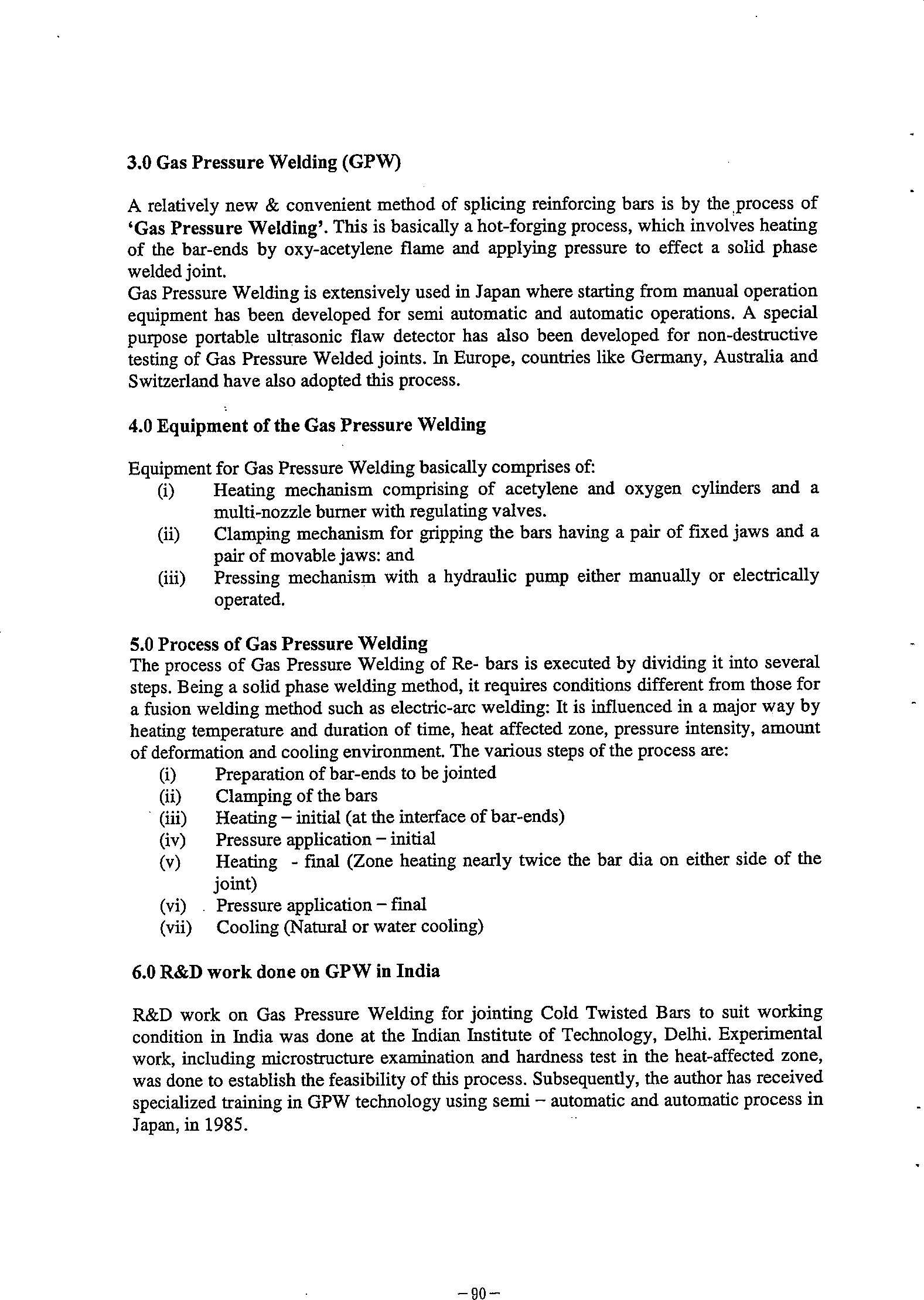
Wherever facility for electric **arc** welding **or gas pressure welding** is available, welding of bars shall be done in lieu of overlap. The location and type of welding shall be got approved by the Engineer-in- Charge. Welding shall be as per IS 2751 and 9417.

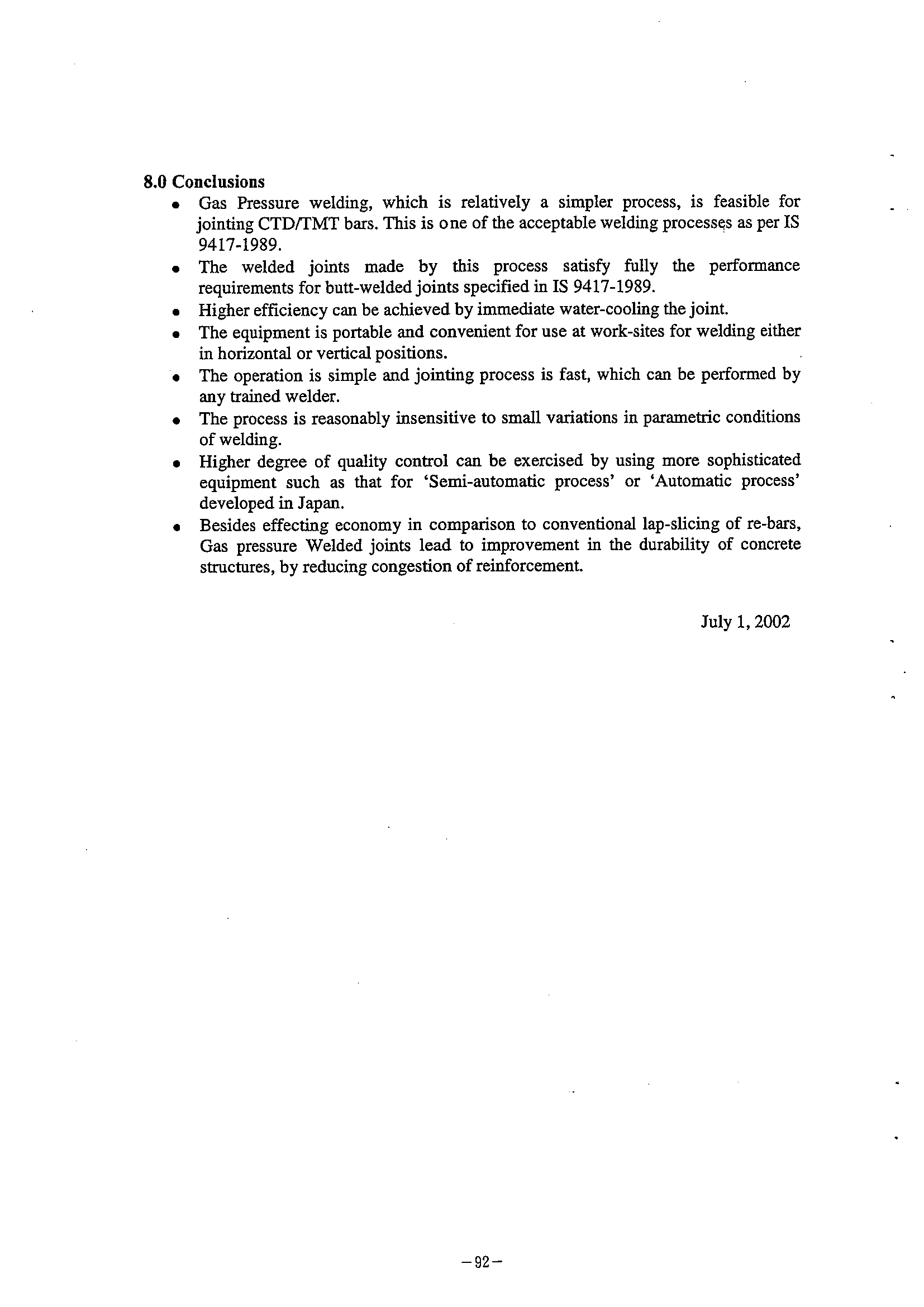
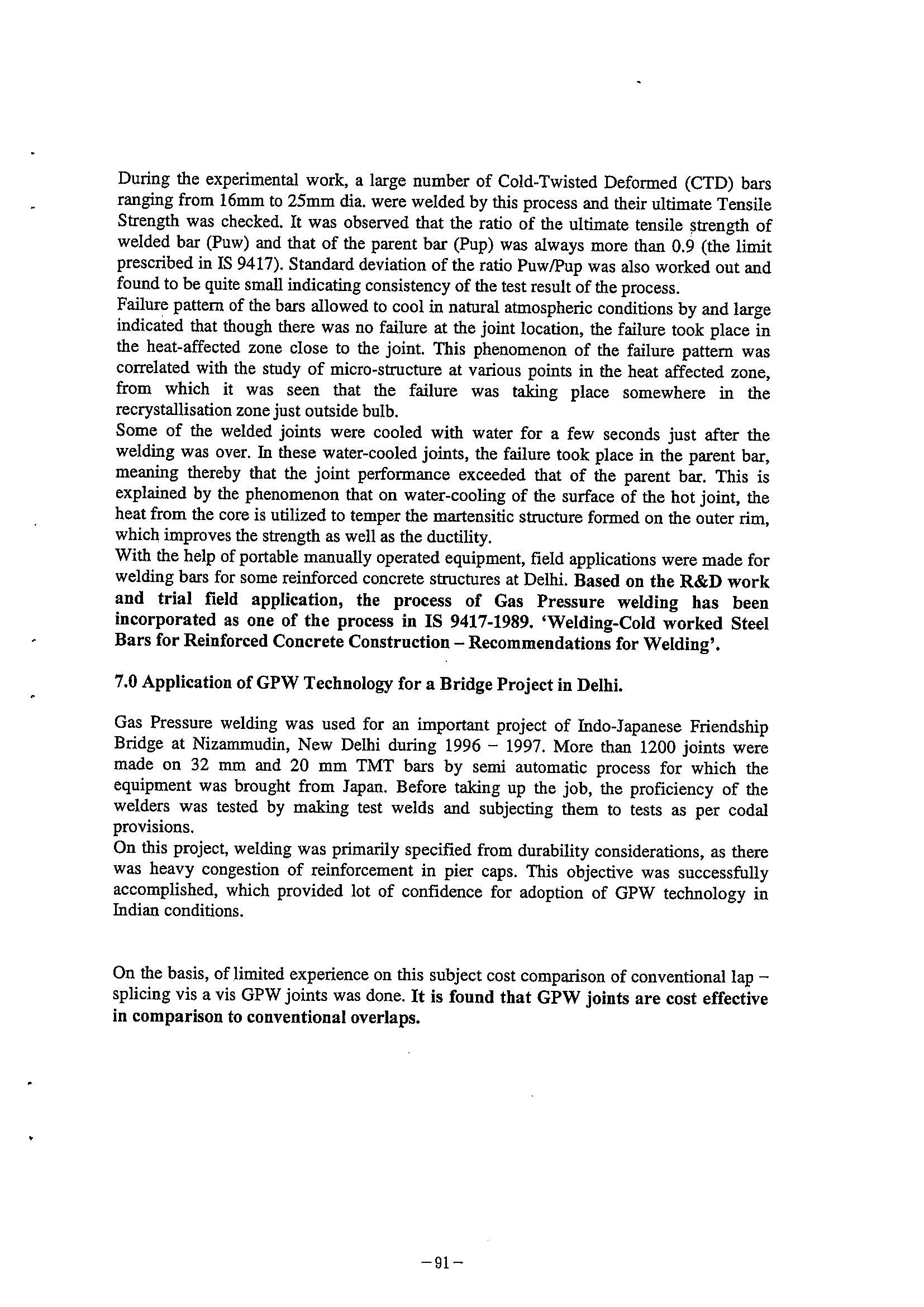
#### Placing in Position

* + - 1. Fabricated reinforcement bars shall be placed in position as shown in the drawings or as directed by the Engineer-in-charge. The bars crossing one another shall be tied together at every intersection with two strands of annealed steel wire 0.9 to 1.6 mm thickness twisted tight to make the skeleton of the steel work rigid so that the reinforcement does not get displaced during deposition of concrete.

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