



IIT MADRAS

Indian Institute of Technology Madras

Technology Transfer Office TTO - IPM Cell



Industrial Consultancy & Sponsored Research (IC&SR)

METHOD OF TESTING 'QUENCHED AND SELF-TEMPERED (QST)' OR 'THERMO-MECHANICALLY TREATED (TMT) STEEL REINFORCING BARS

IITM Technology Available for Licensing

PROBLEM STATEMENT

- The Thermo-Mechanically Treated (TMT) steel are scientifically known as Quenched and Self Tempered (QST) steel.
- The cross-section of good TMT/QST steel reinforcing bars (rebars) should have a ductile core of 'ferrite-pearlite' (FP) and a continuous and uniformly thick peripheral ring of hard 'tempered martensite' (TM) microstructure.
- However, recent studies on TMT/QST steels in the Indian market observed the presence of discontinuous, eccentric, and non-uniform TM-phases at the periphery, which can be attributed to the improper quenching.
- This could result in localized corrosion and variations in the mechanical properties as per IS 1786: 2008.
- In this scenario, a standardized test is essential to assess the quality of TMT/QST steel rebars.

TECHNOLOGY CATEGORY MARKET

Category: Civil Infrastructures & Structural Engineering

Industry: Research Institution, Construction and Manufacturing.

Application: Quality checks at both the steel plant and construction site.

Market: The global Civil infrastructure market Size estimated at **USD 8.7 Trillion in 2022** and is projected to reach **USD 15.4 Trillion by 2032**, registering a **CAGR of 5.9%** during the forecast period from **2023 to 2032**.

INTELLECTUAL PROPERTY

IITM IDF Ref. 1566;
Patent No: IN 533772;

TRL (Technology Readiness Level)

TRL-4, Experimentally validated in Lab;

Research Lab

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TECHNOLOGY

- ❖ **Test method** for the **quality control of steel reinforcing bars** used in **concrete structures** using **macroetching and imaging procedures**

PURPOSE

- ❖ A **standard test-setup** and output qualification procedure as a small-scale lab test for **"offline" quality control testing** of **microstructural phase distribution** in steel rebar cross-sections (not surface).

CONVENIENCE

- ❖ **Visual qualification** criteria and reference images for recommended phase distribution. Quantification procedure for stringent and detailed analysis of the etched output.

TEST SETUP

- ❖ **Table-top test frame** with preset procedure for reproducible results in terms of **lighting**. **Image scale** with respect to the overall **photo-frame** (standardization and output categorization for quality needs).

- **Method of testing steel reinforcing bars** (steel rebar) comprising the **steps** of:

cutting,

Epoxy embedding

polishing the specimen rebar.

Imaging the specimen characterized in that, the specimen is accepted only if the specimen image satisfies visual analysis and thickness analysis.

CONTACT US

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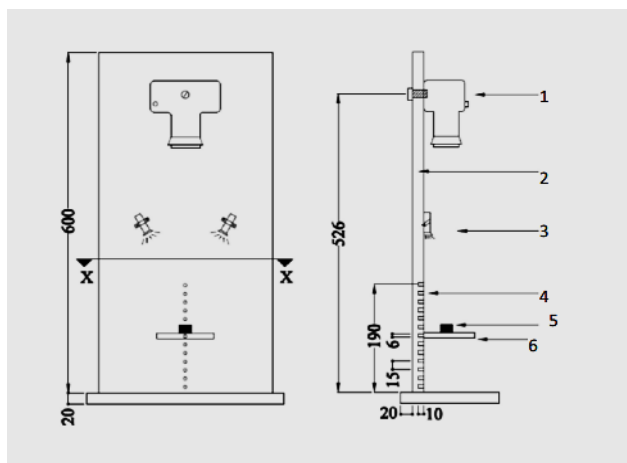
- The **specimen is accepted** only if the specimen **image satisfies visual analysis**, wherein the specimen satisfies the visual analysis only if it meets all of the following conditions:

i) dark grey peripheral region and light grey core seen

ii) the dark grey peripheral region forms a continuous outer ring

iii) dark grey peripheral region and light grey core concentric

iv. Thickness of the dark grey peripheral region is uniform and the thickness analysis wherein, the minimum expected thickness of tempered marten site (TM) peripheral ring is $25 \cdot 0.7D$ and maximum expected thickness is $0.1D$, where, D = Nominal diameter of rebar."



1. Digital Camera
2. Vertical plate
3. Lamps(350 to 400 lux)
4. Measuring scale
5. Specimen
6. Movable base platform

Figure 1 shows the diagrammatic representation of an imaging setup.

Key Features / Value Proposition

- A **custom design** of 'small-scale' lab-test setup.
- Minimal **etching and corrosion exposure** to the **final product**.
- Stand-alone lab-scale test Setup for **etching in 5% Nital** (5% nitric acid and ethanol).
- Representative sample test for quality control to avoid **intentional corrosion** of final product.
- **2-level qualification procedure** –Level 1 as phase distribution categorization with **reference images** for an exhaustive list of **output cases**.
- **Level 2** as a quantification process of phase distribution for **in-line process modification** or advanced analysis.
- **Data acquisition** based on a preset detailed **step-by-step procedure** like (Specimen extraction, Specimen preparation for testing, Specimen testing on "TM-ring test" setup).
- **Post-test output** qualification and quantification for **quality control**.
- Post-scan/**photograph** quality assessment protocol with reference output cases for **visual comparison** and quantifying technique identified for **evaluating the quality of phase distribution**.
- **Exhaustive output cases** with experimental issues introduced for reference output.
- An **easy and fast testing** (**within 5 minutes**)
- **High quality products by testing the corrosion resistance of the steel specimens**,
- **Prevent air pollution** by **discharging fume generated during the test** after the fume is neutralized below a reference value.
- Facilitating the **stakeholders to perform** quality checks at **both the steel plant and construction site**.

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