International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 11 **Issue:** V **Month of publication:** May 2023

DOI: https://doi.org/10.22214/ijraset.2023.52235

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 11 Issue V May 2023- Available at www.ijraset.com

Experimental Evaluation of Quality of TMT/QST Steel Bar by Using TM Ring Test

Mohini Dhongade[1], Rajpari Khaire[2], Shubham Shinde[3], Amar Shelke[4], A.N. Humnabad[5], N. V. Khadake[6]
[1, 2, 3, 4, 5, 6]*Dept. Of Civil Engineering, JSPM Imperial College of Engineering and Research, Pune*

Abstract:** This steel is frequently used on our construction site. However, there are numerous issues with the quality of this steel. Recently, a test method for evaluating the calibre of tempered Martensite rings on TMT steel was developed and refined. The tempered Martensite ring gives TMT rebars their strength, while the ferrite pearlite core gives them their ductility. Because of their unique properties, we use them in earthquake-resistant systems that require both strength and ductility. We bend these components at a 135-degree angle for use in stirrups. A typical 135-degree bend stirrup is seen here. Because of its superior surface crack resistance, TMT rebar will not have a cracked surface. Steel has been employed in structural applications for many decades due to its durability. Designers advocate high strength steel bars in a contemporary concept to reduce steel consumption in reinforced cement concrete (RCC) structures. Microalloying, thermomechanical treatment, cold working, and other methods are used to manufacture them. Some designers believe that thermomechanical treatment (TMT) steel bars are more sensitive to corrosive environments. Corrosion behaviours of high strength steel bars of 500W (weldable steel bar of yield strength 500MPa) grade from two different local industries in fresh water and sea water were studied and compared to weldable low strength (yield strength 300MPa) bars from the same companies. The addition of minor amounts of alloying elements such as Cr, Ni, and Cu enhances the corrosion resistance of steel bars in all test mediums, but strength levels have no effect on the corrosion rate. There is also a link between the degree of tensile property loss and the severity of corrosion damage.

I. INTRODUCTION

As you can see on the bottom left, there is a single house, another photo of rural housing, and another picture of urban housing, multiple story apartment complexes, and so on. In addition, with the goal of providing shelter for all Indians. So, but we have a lot of these projects going on, and if we don't make sure that these projects are created with quality or durability in mind, we'll wind up with a lot of repair and maintenance work. And occasionally, we might not even be able to undertake repairs of that size. This raises a legitimate issue, making the course all the more crucial. The objective is to keep these structures safe and functional for a long time—up to several decades, depending on the type of structure—without performing a lot of maintenance or repairs. Without much maintenance and repair because it's not actually a significant task if we think about merely keeping up with repairs and maintenance. So, building structures with durability in mind, ensuring that repair works are minimal, and if we do repair, ensuring that the repair also lasts for a long time as a result of various projects. So, you know, this is required for this course. Let's take a look at the current situation, particularly in the bridge business in India, for concrete bridges or, you know, bridges in general, whether they're constructed of concrete or steel.

So, the government of India recently conducted a survey of approximately 1.7 lakh bridges through the program on Indian Bridge Management System (IBMS) by the ministry of road transport and highways. They discovered that 6000 bridges are structurally deficient, which is perhaps, you know, for a country like this, you know, I genuinely believe the true figure might be much higher because sometimes we find it very difficult to obtain data, and even when we do obtain data, the quality or correctness of data is another thing. So far, this has only covered bridge.

What about structures? There are several buildings in our country that are of varying quality and age. So we have a lot of historic buildings as well as new buildings being created nowadays. So we have a massive or Herculean task of maintaining existing concrete infrastructure, not just bridges and buildings, but many others, as well as building new ones with durability and corrosion resistance in mind.

II. OBJECTIVE OF STUDY

A. Aim

Main aim is experimental evaluation of quality of Tmt/Qst steel bar by using TM ring test

B. Scope

TMT (Thermo Mechanically Treated) bars are high-strength reinforcing bars used in building construction to keep structures standing in the event of an earthquake. These bars also contribute to the structure's longevity. TMT bars of high grade provide 20% more strength than steel bars.

C. Objectives

1) Many buildings have collapsed around the world as a result of fire hazards. TMT bars can withstand temperatures of up to 600 degrees Celsius. These are the applications for TMT steel bars. TMT Bar Is Required For All Types Of Construction Purposes And Makes Every Structure Strong And Lasting.
2) To Assess Reinforcement Bar Strength
3) The TMT Bar Bending Test Is Performed To Determine Steel Ductility Without Affecting Steel Strength

III. LITRATURE REVIEW

1) April 2017 Indian Concrete Journal 18(1):27-35 'TM-Ring Test'

A quality control test for TMT (or QST) steel reinforcing bars used in reinforced concrete systems Quenched and Self Tempered (QST) steel is the scientific name for Thermo-Mechanically Treated (TMT) steel. A good TMT/QST steel reinforcing bar (rebar) cross-section should have a ductile core of 'ferrite-pearlite' (FP) microstructure and a continuous and evenly thick peripheral ring of hard 'tempered martensite' (TM) microstructure. Recent tests on TMT/QST steels in the Indian market, however, discovered discontinuous, eccentric, and non-uniform TM-phases near the periphery, which can be related to incorrect quenching. This could lead to localised corrosion and changes in mechanical characteristics. Although IS 1786: 2008 discusses etching of steel to determine microstructural phases, it is an insufficient (lacks requisite test protocols; results in incorrect results) and non-mandatory provision offered in the annexure. Details on specimen extraction, preparation, testing, and analysis, which are critical for reproducible and accurate results, are provided, as well as a 2-level acceptance criteria for TMT/QST rebars for future incorporation into standard specifications.

2) Thermo-Mechanically-Treated (TMT) steel reinforcing bars with varying microstructures and mechanical properties

Asian Conference on Ecstasy in Concrete, January 2015 In India, Thermo-Mechanically-Treated (TMT) or Quenched-and-Self-Tempered (QST) steel bars are widely utilised in reinforced concrete construction. The distinct microstructure (for example, with a hard exterior and a soft/ductile core) contributes to adequate surface hardness and ductility. To ensure quality construction, the distribution of tempered martensite and ferrite-pearlite in the cross-sectional region should be concentric and consistent, with moderate variations in yield strength and elongation. Four commercially available TMT steel rebars were examined for their microstructure, yield strength, and ductility in this study. Multiple specimens of 500D Grade TMT/QST bars with diameters of 8, 12, and 16 mm were tested. The results demonstrate considerable differences in microstructure features (such as the distribution of martensite and pearlite-ferrite areas) and mechanical properties. (This includes yield strength, tensile strength, and elongation/ductility). These findings indicate that there is an urgent need to revise the existing IS 1786 (2008) criteria in order to provide higher quality TMT/QST steel products.

3) Mechanical Property and Weight Variability in Reinforcing Bar September 2017 IOP Conference Series Materials Science and Engineering 230(1):012002 Saudi Arabia

DOI:10.1088/1757-899X/230/1/012002 3.0 Creative Commons Licence Authors: F. Djavanroodi

The variability of the physical and mechanical properties of reinforcing steel influences the performance of reinforced concrete structures and falls under the category of material property variations. These qualities have minimum standards in Saudi Arabia, as described by ASTM International Standards A 615. The heterogeneity in the weight and mechanical properties of reinforcing steel manufactured throughout Saudi Arabia is evaluated experimentally in this study. The findings were analysed to determine which firms meet the ASTM International minimal standards. 130 ASTM 615 grade 60 samples were collected and evaluated from various manufacturers to determine yield strength, tensile strength, and elongation. The findings were analysed to determine which firms meet the ASTM International minimal standards. 130 ASTM 615 grade 60 samples were collected and evaluated from various manufacturers to determine yield strength, tensile strength, and elongation. There were 96 samples tested for percent of nominal weight.

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A statistical examination of the characteristics of steel rebar is performed. To determine the distribution type and conduct the statistical analysis, Easy Fit (5.6) software is used. The results of the investigation revealed that yield, tensile, and elongation all follow various forms of continuous distributions. Finally, control charts for the three tests are constructed in order to identify values above and below the 3 sigma.

IV. METHODOLOGY

A. Re-Bend Test

This test is intended to assess the impact of strain ageing on steel. Strain ageing is an embrittlement effect caused by nitrogen diffusion in steel during cold deformation. Because these steels have decreasing toughness at lower temperatures, the risk of fracture on bending increases as the temperature decreases. As a result, temperature parameters should be followed exactly as specified by the code for the best results.

The Re-bend test involves bending a sample of TMT Re-bar through plastic deformation by placing a force against an appropriate mandrel to a 135-degree included angle. The bend sample should be aged for 30 minutes in boiling water (100 degrees Celsius) and then let to cool. The sample should be bent back to a 157.5 degree included angle. Typically, tests are performed at room temperature. The mandrel diameters used for various grades of TMT Re-bar are listed below.

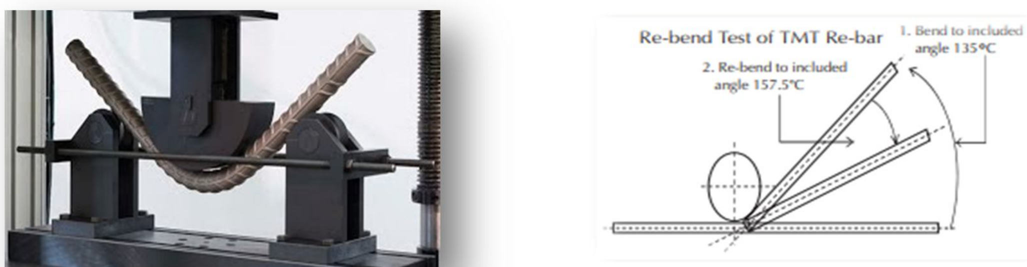

Fig 1) Re- bend test

The sample used for the bend test should not be used for the re-bend test.

It is critical to ensure that the load applied to the sample bar is uniform, smooth, and vertically downwards. It is best to avoid using an impulse load.

B. What Exactly Is The Yield Stress Test In Tmt Bar?

Which level of stress can a material withstand? At what point will it begin to deform plastically? This information can be obtained during the Yield Stress Test/0.2% Proof Stress. The material will bend elastically until it reaches the yield point and then revert to its original shape when the applied load is removed.

Starting at 0.002 strains, the conventional technique is to project a line parallel to the initial elastic area. The 0.002 strain point is also known as the 0.2% offset strain point.

The material's behaviour can be divided into two categories: brittle and ductile. Steel and aluminium are common ductile material failures. Glass and cast iron are examples of fragile materials. The stress-strain curve can be used to distinguish between the two types. Alternating Current Components

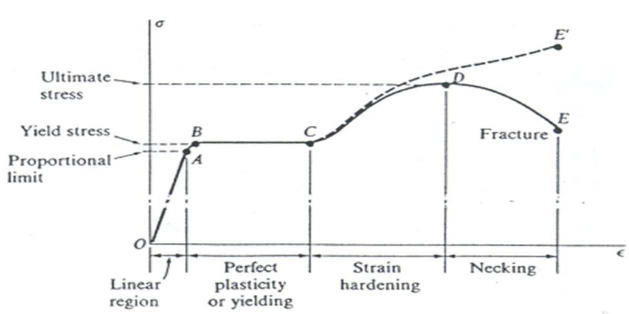

Fig 2) Yield strength of steel

Fig 3) Model

C. Iron Scrab List

1) 12 mm dia. of bar = 02 Nos, 18" length.
2) Square tube = 02 Nos.
3) Colour= half a liter.
4) LED Lights = 02 Nos.
5) Bolts = 02 Nos.
6) Angels = 04 Nos, 4" length.

[Note:- 90% model is made from scrap materials.]

After that, we took the welding machine and welding rod from the fabrication worker on our site to make the model and started making the model.

After making the model for the first time, I had to make some changes to the model again. Those changes are as follows:

a) The mobile holder had to be adjustable.
b) The color of the model had to be changed.
c) The lighting angle had to be changed.
d) Sample holder had to be fixed in place.

Procedure

- Place the made model on a flat surface.
- After that all the STEEL BAR's were cut to 2" length and filed.
- Take ethyl alcohol 93% and 7% nitric acid in a beaker and mix well in the same manner.
- After mixing all the bars cut in the mixture, keep the mixture for at least 5 minutes.
- And to see its result, put it in the bar model and take its photo and get its result.

We first collected scrapmetal to model the project itself.

D. The Reasons for the change are as follows

1) *Mobile holder had t be Adjustable:* In the previous model we kept the sample holder adjustable. But because of that we were not getting accurate results. Because the steel sample used to be in a state and the photo could not be taken properly due to the movement of the sample.
2) *The color of the Model had to be Changed:* The color of the previous model was black. But the color of the sample was black. Then 2 because the color was black, I could not understand what the result was on the sample and the photo was not coming out.
3) *Lighting Angle had to be Changed:* The angle of the light had to be changed for this, because the mobile holder was adjustable, the light was not focused on the sample which was kept on the plain surface.

E. Testing Errors are Possible

These are mentioned ahead of time so that the user understands the errors and can avoid them during the "TM-ring" tests.

- Result 1 depicts the removal of stains (which formed the dark ring) while wiping away extra solution (by hand). In such circumstances, the user should promptly wipe/clean the surface using a moist cloth.
- Result 2 happens as a result of insufficient and incorrect polishing. A portion or the majority of the surface area may remain dark. At the same time, some of the surface becomes scratched, revealing the colour difference. It is suggested that the specimen be polished again and the tests be repeated. When the concentration of nital is excessively high (say, more than 10%),
- Result III may occur. It should be noted that if the nital solution is not adequately stored, the alcohol component may evaporate and the concentration may rise higher than planned.
- Result IV can occur when the test specimen is cut (from a rebar piece) without using any coolant and the cross-section gets damaged. It is instructed to procure a new specimen and continue the test. The user shall also extract a new test specimen from a distance of 3 times the diameter from the cut end (or heat affected zone) of the rebar. Also, ensure that a coolant is used for all the cutting procedures.

ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
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F. Discussion

A high-quality rebar should have a continuous, concentric, and uniform TM phase, as well as a core with FP phase (as seen in Figure). on the other hand

A low-quality rebar, on the other hand, could demonstrate one of the three flaws (i.e., discontinuous, eccentric, or non-existent) uniform) or a mixture of these.

These flaws could occur as a result of poor quenching in the In-Line QST procedures. This study attempts to categorise these flaws generically as follows:

1) Eccentric and non-uniform TM-phase: When the TM-phase at the perimeter is continuous but eccentric, and the thickness is non-uniform.
2) Discontinuous and non-uniform TM-phase: This refers to situations in which the TM-phase at the periphery does not form a complete ring and is discontinuous at one or more locations (i.e., both the FP and TM phases are exposed at the surface); and has a non-uniform thickness.

According to the observations. Section 4.1 outlines the possible outcomes of the TM-ring test as well as the mechanics of their evaluation.

General classification of "TM-ring" test results

Figure 's Reference Cases A, B, C, and D illustrate

The "TM-ring test" has four possible outcomes. Case A

Cases A, B, C, and D imply high quality, whereas Cases B, C, and D indicate low quality.

Inadequate quality.

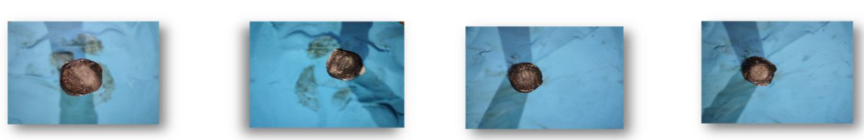
Figure depicts an ideal rebar with a continuous, concentric, and evenly thick TM-ring. It was discovered through laboratory experiments on various steel rebars acquired from the market that this type of perfect TM-rings are primarily prevalent in big diameter rebars and are absent in rebars with less than 16 mm diameter. Furthermore, such small diameter rebars are used as stirrups with a shallower cover depth than larger diameter primary reinforcement. This suggests that for smaller diameter rebars, better quality control is essential.

Case B in Figure 8 is an example of TM phase that is continuous, eccentric, and non-uniform. The ring thickness is exceedingly thin in two areas on the image's left side. This is most likely to happen if the coolant temperature or pressure is not uniform around the circle. As a result, a differential temperature gradient occurs, resulting in a TM ring with non-uniform and insufficient thickness in some areas. These flaws were most commonly detected in 12 and 16 mm sizes. On the other hand, overquenching at specific spots can result in a TM-ring with a non-uniform and more than enough thickness in some areas.

Figure depicts a non-uniform TM-phase with dispersed discontinuities. This cannot be defined as a photograph taken with a measuring scale next to a test sample.

(April-June 2017) Pictural This is an example of concentricity. This could happen if the quenching hardware fails to work (e.g., clogged nozzle) at some points on the surface of the rolled rebar during the cooling step. In theory, a discontinuity arises when the minimum thickness of the ring in Case B becomes 0.

1)	2)	3)	4)



5)	6)	7)	8)

EXPERIMENTED BARS OF DIFFERENT DIAMETER

V. CONCLUSION

The study introduces a potential quality control concern in the fabrication of TMT/QST steel rebars in the Indian market within its scope. Defects in the peripheral tempered martensite (TM) ring and ferrite-pearlite (FP) core of TMT/QST steel rebars with diameters of 8, 12, and 16 mm. The probable faults were divided into three categories: discontinuous, non-uniform TM-ring, and eccentric FP core. To analyses the cross-sectional phase distribution (CSPD) of TMT/QST steel rebars, a "TM-ring test" technique has been developed/documented. The test protocol comprises instructions for specimen extraction, preparation, macro etching, analysis, and result documentation. The new "TM-Ring" test might be used by technicians at steel plants and building sites to assess CSPD quality. The authors gratefully thank funding from the Ministry of Human Resources Development (MHRD) via the Indian Institute of Technology Madras (ITM), Chennai. The authors would like to thank Prof. Ravindra Gettu for his encouragement and advice throughout this effort, as well as Mrs. Malarvizhi and Mr. Subramanian from the Department of Civil Engineering for their assistance with the experimental work. The authors additionally appreciate the Department of Metallurgical and Materials Engineering's laboratory help.

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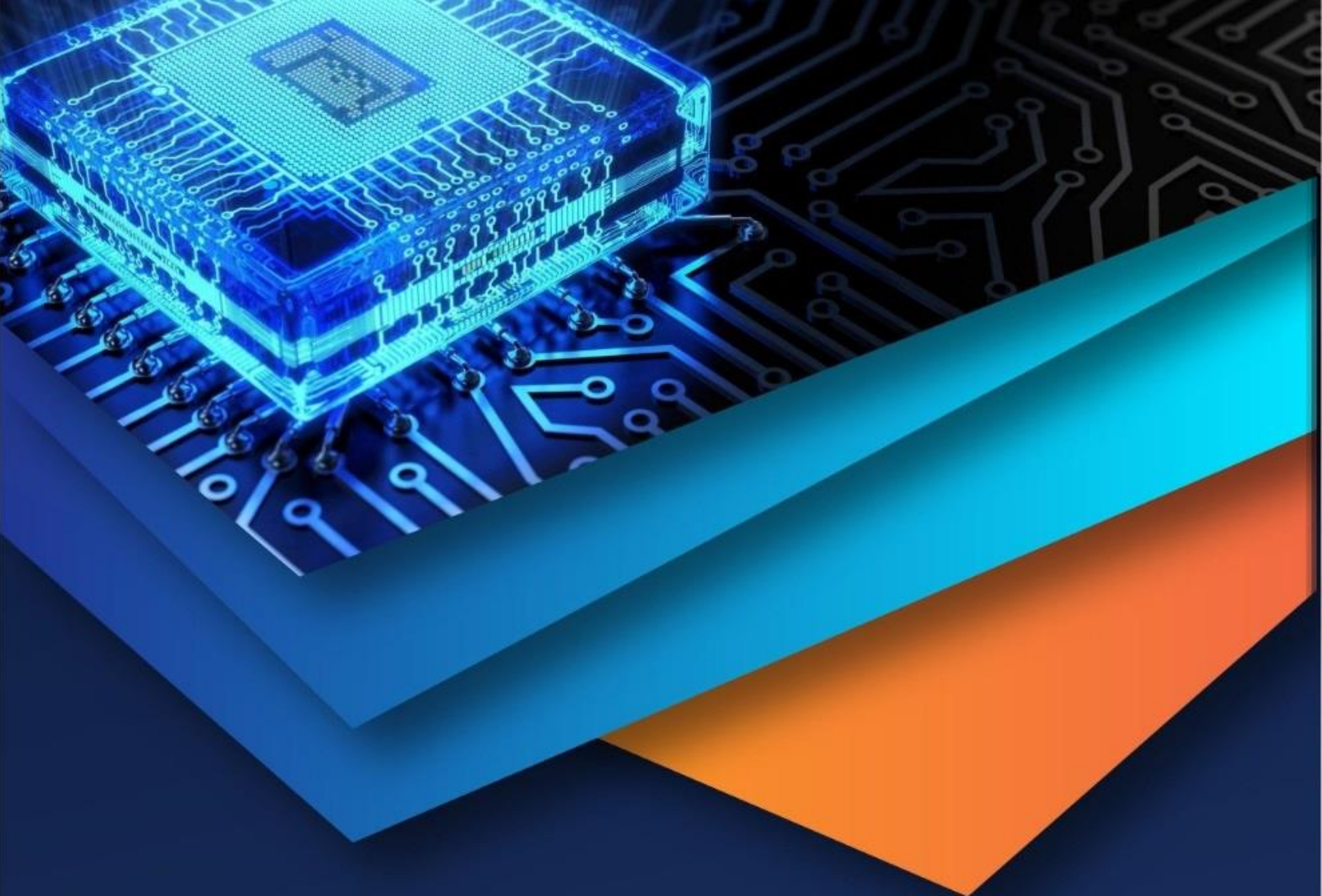

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