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Study Report on Failure Analysis of TMT Bar Due to Steel Defects

Pramod Kumar
Department Metallurgical and Materials Engineering
National Institute of Technology
Warangal,AP,India
pramodmeta@gmail.com

***Abstract*- Thermo-mechanical treated (TMT) rebar is used as material for reinforcing concrete structures due to its unique Properties of thermal expansion, ability to bond well with concrete and resist the tensile stress acting on the structure and also steel manufacturing industry has successfully developed a corrosion- resistant variety of rebar for the construction industry. By controlling the proper rolling parameters and water quenching box is required to achieve adequate property. Water quenching box & used billets plays an important role for achieving the final structure and property of the rebars as well the bend properties. Steel quality of the rolled billets are for the production of good surface finish quality TMT bar & also passed in bending of bar. The present paper highlights failure investigation of a failed rebar during bending operations. From micro structural analysis & study of fracture surface it is confirmed that the rebar sample failed in ductile manner due to the steel defects like sub surface blow holes inside the rolled billets originating from thecaster.**

***Keywords*: - Rebar, water quenching box, themo mechanical teatment, blow holes.**

I.INTRODUCTION

The TMT bar produced from the input billets of different sizes (125x125mm &150x150mm) & containing the various types of internal defects like piping, center looseness, sub surface blowholes, rohombodity& slag patches. These defects are steel defects & are generating mainly from the caster & melting furnaces. Defects like piping & sub surface blowholes could not getting welded during the rolling of bar & it's getting opening at in TMT bar produced.

These defects are elongated in during rolling & cracking the bar during the bending operation in end use. The severe piping defects inside the billets got cracked & cobble takes places at finishing mill. Heavy rejection of TMT bar occurred if these defects are inherited inside the billets. In this present work failure analysis of failed rebar samples during bending operations was carried out to find the geneses of failure.

II. EXPERIMENTAL STUDY

Cast number of failed re bar samples trace out to see the macro etched billets internal defectsof the tolled TMT bar & macro etched samplesof failed bar thoroughly studied visually as shown in figure- 2.Also, the end cut samples of shear cut collected from mill stand of same heat billets for visual study & it was shown in figure -3. The TMT failed bend samples was shown in figure -1.

One piece of failed re-bars samples during bend test was collected from the bending test machine at bar mill quality control laboratory. The sample was cleaned with acetone to remove dirt for visual examination. & it was seen under the stereo type of microscope (LIECA, Germany) at magnification of 400X to identity nature of failure. For micro structural analysis samples were individually mounted in electrically conductive copper-containing resin and polished by conventional metallographic techniques. The polished samples were etched with 3% nital solution (3 ml HNO3 in 97 ml ethyl alcohol) for analysis of microstructure and studied under light optical microscope (LOM).

III. EXPERIMENTAL RESULTS

1. Visual observation: Visual observation of the cracked samples done and it was found that the crack is elongated during the rolling process. In the billet inspection it was also seen that blow holes and piping defects observed as shown in the figure 1 and figure2 a and b. These defects are generated during the casting process and rolling of the billets. The TMT bar showing the line types of cracked defects along with the rib of the samples.

Fig 1. 8mm TMT Bar cracked during bending of operation on the transverse rib.

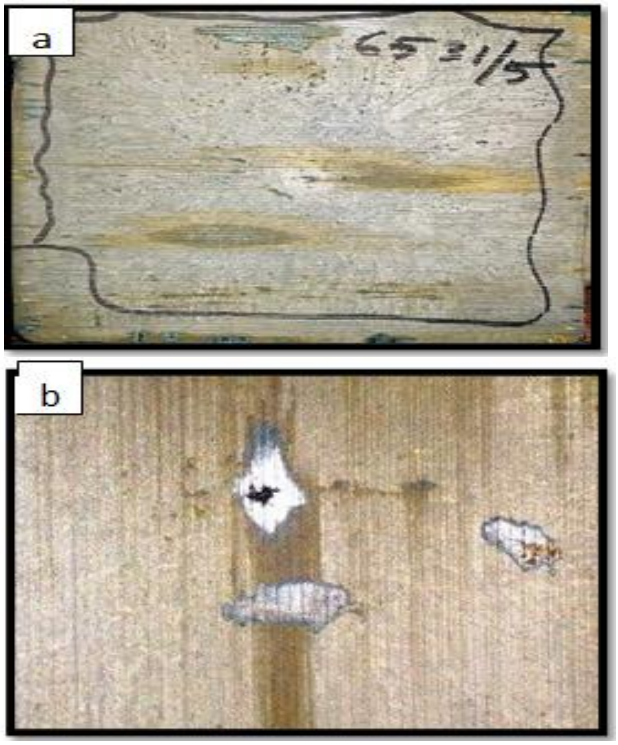

Fig 2. (a) Image of billet samples showing blow holes (b) Image of billet samples showing blow piping defect in the center of the sample.

\Fig 3. Image of billet samples showing blow hole defects rolled in bar during rolling.

2. Micro structural analysis:

Specimen of the cracked portion of the bar was prepared in transverse direction, etched with3% nital and studied under inverted LOM at different magnifications for micro structural evaluation at core and edge of rebar sample. Predominantly through tempered martensite matrix was observed at periphery to edge& pearlitic matrix at the core as shown in fig. 4a, b&c.

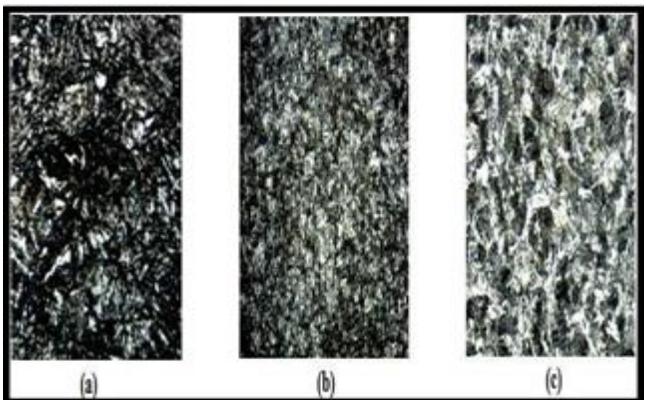

Fig 4. Microstructure showing (a) tempered marten site at edge (b) at boundary (c) Pearlitic structure at the core

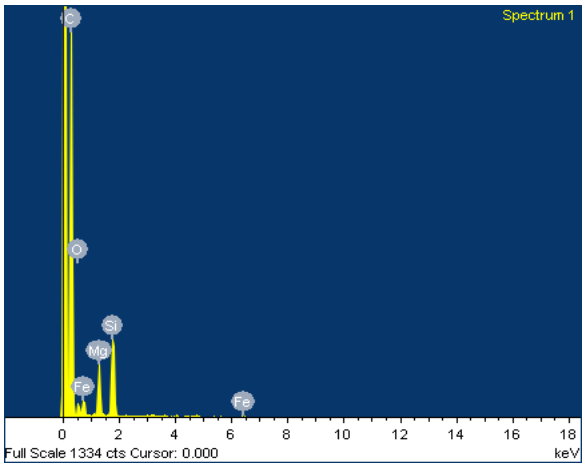

Fig 5. (a)SEM image showingthe cracke defects X8000

Element	App	Intensity	Weight%	Weight%	Atomic%
	Conc.	Corrn.		Sigma	
C K	0.18	0.9505	32.60	1.14	54.45
O K	0.18	1.4842	19.59	0.85	24.56
Al K	0.03	1.0323	5.33	0.29	3.96
Si K	0.03	1.0268	4.99	0.30	3.57
Fe L	0.15	0.6404	37.49	1.64	13.47
Totals			100.00		

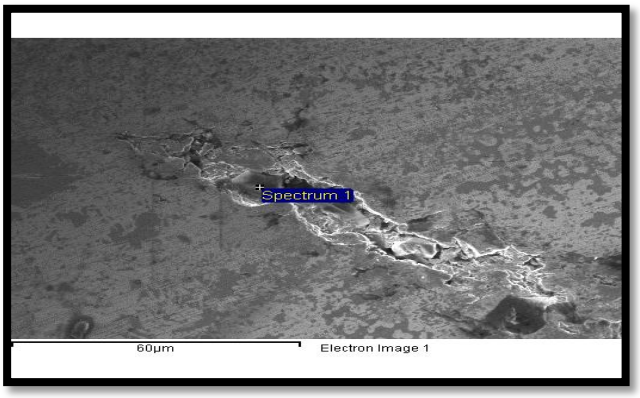

Fig.5 (b) Compositions of thecracke portion identified using energy dispersive spectroscopy.

The SEM&EDXS study showed in the figure 5(a) the cracks at magnification of 8000 in the TMT bar samples. In Figure 5(b) EDXS report shows that Oxygen, Aluminum and Silicon elements observed. This shows that during casting process Al &Si intrapped in the cast billets which may be from casting powder etc.

IV. DISCUSSION

From the visual examinations of the cracked samples in TMT bar & the after detailed visual as well as metallographic study is clear indication that the defects originating from steel making & casting process in a billet. During the rolling operations defects like sub surface blow holes were opening in the bar as elongated in shape. It was also randomly distributed along the length of the TMT bar as shown inFig.3. Also, in the metallographic study there is no any phase's abnormality due to water quenching box.

V. CONCLUSION

The failure of the TMT bar in bending operations are mainly due to the presence of steel defects like blow holes & piping which are mainly originating from the casting process at caster & when billets are rolled its getting opening thought the length of bar.

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