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Effect of Rolling Temperature and Rolling Speed on Mechanical Properties of QTB Passed TMT re-bar

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TMT re-bar is produced by using QTB process where hot-billets are rolled through several horizontal and vertical rolls then passed through water for quenching purposes. Mecanical properties such as yield strength, Ultimate tensile strength, elongation and bending properties are depends on previous thermo mechanical treatment, billet Chemistry and cooling rate at quenched and tempered bath of re-bars. In this paper, we only discuss about effect of billet temperature and last stand speed on yield strength of re-bar. It is found that high billet temperature produces a low-yeild re-bar where as high speed produces a low yield re-bar too due to soaking effect at furnace and cooling effect at QTB respectively.

Keywords: TMT re-bar, temperature,Speed

1. Introduction

Depending upon temperature of metal working, it can be divided into two branches cold working process and hot working process. From about 1000 BC to the present day, iron has been the most used metal. In terms of usage, rolling processes more tonnage than any other manufacturing process. The advantage of hot rolling over cold rolling is we can reduce more thickness by hot rolling. Large size reduction is possible by hot rolling because here the thermo mechanical process that used includes recovery and recrystalyzation process. On the other hand, hardening of metal is the major problem for cold rolling so, annealing is the intermediate steps that have to used to achieve severe size reduction by cold rolling process.

Re-bar produching process is a heating and subsequent rolling process where Billet is an input. Large square shape billet of 150mmX150mmX 12 m approximate size is pushed into a pusher type re-heating furnace and heated continuously it's head, middle and tail portion of about 1200 to 1250C such that iron can convert totally into austenite phase. When billet is passed through grooves of subsequent rolls its size is reduced to a required shape, a process called a thermo mechanical treatment. As same amount of material have to pass through all stands material should follow Continuity equation (1) Where A is the cross sectional area of bar and V is the speed of bar.

$$AXV = Q \qquad (1)$$

Speed required of a particular stand is related to roll diameter of a particular stand also. And all stands are electronically connected such that the same amount of material have to passed for a particular time by producing particular required speed for rolls of a stand. However, for any reason such as slight wrong parameter of roll

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dia input by operator can be balance by observing tension and compression between stands by decreasing or increasing speed of a particular stand.

Re-bar gained proper strength through a process called quenched and auto tempering process. In this process first bar have to quenched in a water bath from austenite phase, a process generally called quenching process to attain required strength of re-bar then it automatically tempered by the core heat of the bar it-self. QTB process consists of proper number of Cooler, stripper and dryer set up. Water flow and pressure of QTB set up such that we can gain proper yield strength of a re-bar. First bar is passed through Coolers for quenching purposes then it passed through Stripers and dryer to remove residual water that stick with re-bar by water and air respectively. As this type of quenching process a re- bar spend few time into QTB bath for quenching so as it passed QTB re-bar's surface gradually heated from the heat gained from core of the bar. Surface martensite structure will be changed to tempered martensite structure. Thus strength and toughness both can be achieved by this QTB process. Previously a study has been conducted on effect of hot rolling conditions on the physical properties of a carbon steel without using QTB (Free Man and Derry, 1924). Still now there have no documents available that describe the effect of billet temperature and mill speed on yield strength with using QTB. In this study I have used QTB to find yield strength by varying billet temperature and mill speed of re-bar.

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The paper is organized as follows: Section 1 contains Introduction and Section 2 provides literature review. The methodology and model are presented in section 3 and the findings are reported in section 4. Section 5 contains conclusion.

2. Literature Review

Rolled product has improved quality compare to its parent material. Rolling eliminates many defects and introduced texture into material (Akpan and Haruna, 2012). Cast billet has coarse grain structure whereas rolled product has fine grain structure (Saheb, 2013). Re-bar shows ring type structure consists of inner ferrite-perlite structure surrounded by tempered martensite structure. If the temperature is high the metal will be soaked more hence the less should be the product yield strength. Again all stands speed will be automatically set up if we set last stand speed in modern hot rolling mills (Martin, 2011). If we increase the speed, the re-bar should have lower yield strength because the thickness of martensite ring will be thinner. The initial temperature of rolling, finishing temperature of rolling, total reduction, pass reduction and roll speed can effects on ultimate strength, yield strength, proportional limit, elongation, reduction of area, resistance to impact, hardness, microstructure and density (Free Man and Derry, 1924).

3. The Methodology and Model

In this paper, we noted the variation of temperature and speed on yield strength of modern Danieli rolling mill that set up in Fouzdarhat, Chittagong named BSRMSL. Yeild strength were measured by UTM (Servo-hydraulic Universal Testing Machine) machine, Model:SHT 4206, that also set up in BSRMSL, With this machine we can apply up to 2000 KN load and chemical composition were measured by SPECTROLAB, Model: M10, Sr. No. 130688 that also set up in BSRMSL, we can standardization this spectrolab machine.

4. The Findings

Table 1 shows four re-bar yield strength and chemical data taken from four heat. It can be clearly seen from row 1 and row 2, that if we increase temperature then the re-bar yield strength decreases. Again it can be clearly seen from row 3 and row 4, that if we increase mill speed then the yeild strength of re-bar decreases also.

Table 1: Temperature and Speed Data for Re-bar: XTREME 500 W 16

Soaking left, C	Soaking right, C	Heating, C	Furnace Exit Temperature, C	Mill Speed, m/s	Yeild Strength, MPa	Chemistry, %
1245	1234	1190	1180	8.0	530	C=0.21, Mn=0.76, Si=0.25, P=0.033& S=0.028
1232	1245	1179	1161	8.0	550	C=0.19, Mn=0.73, Si=0.23, P=0.035& S=0.028
1194	1200	1132	1126	7.9	545	C=0.205, Mn=0.698, Si=0.183, P=0.0385& S=0.0442
1217	1218	1132	1132	8.0	525	C=0.22, Mn=0.82, Si=0.243, P=0.0321& %S=0.0314

5. Summary and Conclusions

When billets heated up at high temperature then the microstructure of billet will be coarse grained. These coarse grained structure billets will produce lower yield strength bar (Table 1). This bar will contain larger size needles of martensite. So, the structural morphology with respect to temperature of re bar will be different as we have used QTB process. The investigation of variation of re bar yield strength with respect to temperature of billet using QTB process is a new addition of this research. However microstructural investigation of re bar should be conduct in future research. When we increase the bar speed then the yield strength fall down (Table 1) because of lower quenching effect of QTB. This type of yield variation using QTB is a new research. We have to done more research on macrostructural investigation of re bar using QTB. However, the amount of yield variation in this research cannot be exactly relate with the amount of temperature increase and speed increase because there may have lot of other parameters that may influence on yield strength such as reduction and spreading of material etc.

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