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Review of Flash Bainite Technique - Manufacturing of Steel

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ABSTRACT: It is a patented process for heat treating steel that yields the Strongest, Most Ductile, Lean alloyed, Readily Weldable, Least Cost and Maximum Strength Metal known to man.

It can be used in concrete as it is low cost and stronger than the conventional steel. Steel building components can be manufactured to rely on much higher tensile strength. Significantly lighter roof trusses could be constructed from Flash Bainite members with greater tensile strengths. Tensioning components such as wire and re-bar may positively impact the bridge and highway building industries. The Combination of high strength and increased quality of steel allows engineers to design vehicles made from parts that are lighter yet stronger than the existing parts making the vehicle more efficient.

It employs rapid thermal cycling to strengthen steel sheets and tubing into AHSS (Advanced High Strength Steel). This process is environment friendly and consumes less than half Kilowatt of energy per Kilogram of steel processed. Flash Bainite is still a new field for study. More information and principles regarding this topic is still needed to be developed. This review paper has been set up to serve those purposes and fulfill the missing information for any further study.

The aim of this paper is to give a review about the various properties and uses of Flash Bainite for the improvement of the strength of the structures based on various studies done abroad. The paper also gives a review about the process involved, their production and advantages over conventional steel used regularly without awareness.

I.INTRODUCTION

Steel is the leading construction material for sustainability. When a steel-framed building is demolished, its components can be reused or returned to the steelmaking process to create brand new components. Various types of steels have been developed throughout these years to serve the requirements of industries. Different combinations of compositions and processing of this steel yield different characteristics of steels for various uses. Some of them is utilized for mechanical purposes, Civil purposes and some of them have been developed to serve other applications.

In 2010, ARDEC was contacted about Flash Bainite (FB). They produced a steel microstructure of high strength and good elongation and toughness. The process was demonstrated on plain carbon and lean alloyed steels and has been performed on a variety of different forms including sheet, plate, and tubing (round and rectangular).

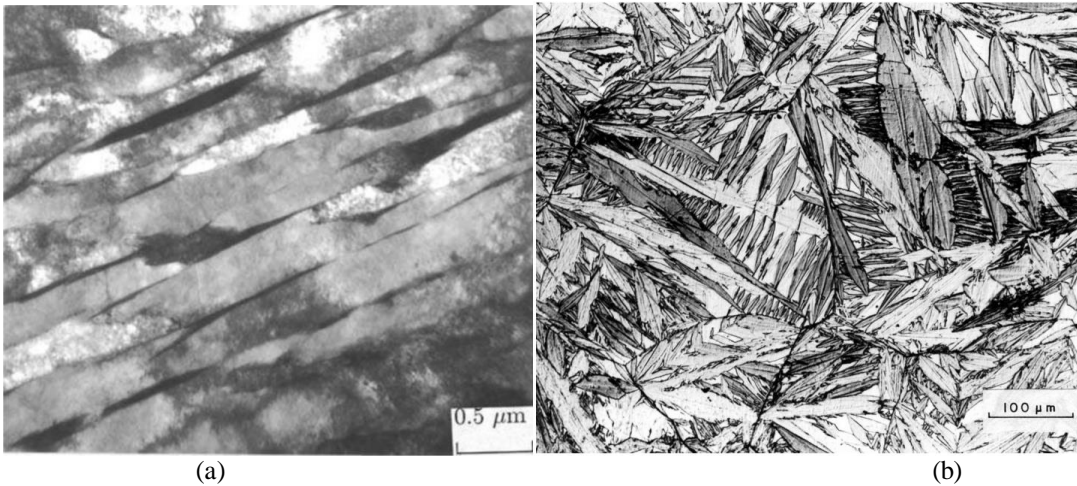
Flash bainite is the latest method of microstructure development by the method of heat treatment process called "Flash Processing". Using this process high performance steel is obtained by treating it for only a short period of time. It is a mixed microstructure of bainite and martensite.

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The microstructure of bainite (a) and martensite (b) With Flash Processing, the microstructure developed is claimed to be a mixture of about 20 percent of bainite and 80 percent of martensite. The resulting steel undergoing Flash Process is called “Flash Bainite”, the process is still new and more details need to be discovered. This is why this research has been set up: to study details of flash process and the flash-processed steels. The study aims to develop understanding of the flash process and the characteristics of steels after undergoing the process.

To meet the properties requirements, compositions and processing of the steels plays an important role. So, in order to achieve the desired mechanical properties, the suitable heat treatment process has to be considered and designed.

II.METHODOLOGY

The process of flashing develops a microstructure which is a mixture of 20% bainite and 80% of martensite. The product undergoing flash process is called Flash Bainite.

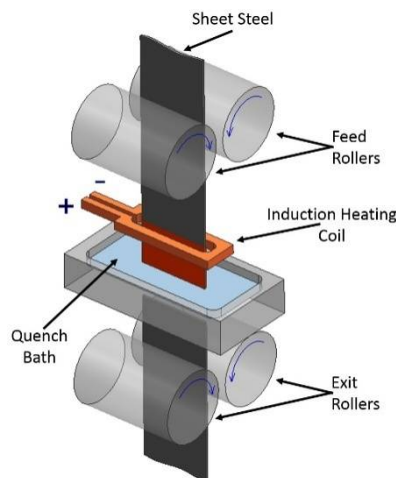


Figure 1. Schematic of Flash Bainite (FB) process for steel sheet/plate

1. Heat Treatment Cycle: This helps one to understand the formation and behavior of bainite obtained from the flash process. Similar process is considered for heat treatment to typical flash process. The heat affected zone lies in the

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central region and it is done individually to the specimens. The study of heat treated steels focusses mainly on the central region.

2. Materials used in this process have high strength and it is a low carbon alloy. The specimens in this study have been treated by heat with similar heat treatment cycles. The steel was morphologically studied and analyzed after the heat treatment and its formation requires certain steps of work.

3. Surface Penetration: On completing the heat treatment a strip of steel was cut down on either end and the central region remaining was considered for further studies. The Sample was surface cleaned before further experiment was to be conducted on it. The process chosen was electron microscopic study. The samples were ground on the surface with silicon carbide paper with 400,600,800 and 1200 grits. The surface of the sample specimen was again ground to reveal the clean and fresh surface, on this occasion only from 800 to 1200 grits. The above sample was polished for 1 hour in the same solution and cleaned in a similar manner.

4. Microstructural Analysis: Three different techniques can be utilized which are optical microscopy, the scanning electron micrograph and the electron backscatter diffraction.

After surface finish samples were studied through optical microscope using Natal Etching technique, Nital is obtained by mixing nitric acid and alcohol commonly used for etching steels. It reveals the microstructure of carbon steels. 2% concentration of nitric acid was used. The results were categorized into 2 groups: 4 samples having bainite and 8 samples without. After the Nital etching the samples were re-ground and re-polished. The surface was cleaned for Picral Etching. Picral Etching is done for heat treated steels. This was to confirm traces of carbon concentration gradient. It also revealed traces of martensite inside the grain which confirms the flash bainite microstructures that have been developed in the samples, formed in a similar manner as a typical flash process.

5. Hardness test: This test is done to represent the mechanical properties of the materials. Vickers Hardness testing procedures were used. It was conducted with a load of 300 gf, 30 indents were put on each sample across the length and the average hardness value was calculated in the unit HV.

Various other tests like Charpy V-Notch test , XRD test and Tensile and Fracture toughness test can be conducted to derive strength of steel developed by flashing technique.

III. CONCLUSION

Flash process and flash bainite is a relatively new heat treatment process and microstructure that need to be further studied to develop more understanding and information about them.

This review paper aims to provide more understanding in morphological and microstructural aspects. It is as strong and ductile as titanium alloys and the cost is almost 20 times lesser than that of titanium alloys.

This process consumes less than a half Kilowatt of energy per Kg of steel processed (less than a penny/pound). In Cola's work, the steels used to develop flash bainite were AISI 4130 and AISI 4140, medium carbon steels. The resulting flash bainite shows properties of high strength and high ductility, opposing to martensitic microstructure steels.

Welding tests demonstrated that Flash Bainite plate is weldable and that welded plate can subsequently be Flash Bainite processed to restore strength.

The impact toughness of the Flash Bainite plate was consistently higher (~2x) than the Q&T plate at all test temperatures (20°C to -40°C).

Vehicles could be made many hundreds of pounds lighter, saving hundreds of dollars in steel costs alone. Flash Bainite is the very product that the US Automotive and Steel Industries have sought for the last 20 years.

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