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Standard diagrams for macrostructure and defects in high quality structural steel continuous casting blank

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Standard diagrams for macrostructure and defects in high quality structural steel continuous casting blank

1 Scope

This standard specifies morphology features, causes, rating principles, assessment methods and test reports of macrostructure-defects in high quality structural steel continuous casting blank. This standard applies to the assessment of cross-section acid etching macrostructure defects in high-quality carbon structural steel, alloy structural steel and spring steel continuous casting blank. Negotiated by both parties of supply-demand, it can also be used to evaluate other steel continuous casting blank.

The size range of continuous casting blank applying to this standard includes: continuous casting blank or rectangular blank with side length 100mm ~ 550mm, continuous casting round blank with diameter 90mm ~ 1000mm (hereinafter referred to as continuous casting blank). Continuous casting blanks with other size can refer to this standard.

2 Normative references

The following documents for the application of this document are essential. For dated references, only those dated references apply to this document. For undated references, the latest edition (including all amendments) applies to this document.

GB/T 226 Etch test for macrostructure and defect of steels

YB/T 4149-2006 Continuously cast round billet for seamless steel tube rolling

3 Classification and assessment

3.1 Sample display method

Sample's cutting and display is carried out according to the provisions of GB/T 226.

3.2 Various types of morphology features, causes and assessment

principles of defects (or tissue)

3.2.1 Center porosity

Morphology features: the gap and dark spots concentrated in the center of acid etching sample.

Causes: when steel-liquid is solidified, the volume is shrunk and there is no enough steel-liquid to supplement; and when final solidification, the gas is accumulated and impurity is concentrated.

Assessment principles: assessment is conducted according to the number, the size and the intensity degree of dark spots and gap in the center of the sample.

3.2.2 Center segregation

Morphology features: in the center of acid etching sample, it shows dark spots with deeper corrosion, and sometimes there are gray-white band and porosity around the dark spots.

Causes: in the process of steel-liquid solidification, because of the impact of the selective crystallization and slow cooling in the central part of continuous casting blank, the component of the heart is segregated.

Note: continuous casting blank bulging emphasizes the degree of segregation.

Assessment principles: assessment is conducted according to the size of dark spots and the degree of color depth.

3.2.3 Shrinkage

Morphology features: In the central part of acid etching sample, it presents irregular cavity.

Causes: in steel-liquid solidification, the columnar crystal-developed and local columnar crystal are "bridged", the final coagulation part of the center is contracted intensively and has no steel-liquid to supplement.

Assessment principles: assessment is conducted according to the size of the cavity.

3.2.4 Internal cracks

3.2.4.1 Corner cracks

Morphology features: At the corner of acid etching sample, there is a certain

depth from the surface and perpendicular to the surface or parallel to the diagonal. In severe cases, the cracks expand inwardly.

Causes: Steel-liquid in the mold, due to the inappropriate external cooling intensity and uneven cooling, result in the stress at the corner of continuous casting blank exceeding the strength of steel.

Assessment principles: The assessment is conducted according to the distance, the width, the length and the number of cracks from the surface.

3.2.4.2 Subcutaneous cracks

Morphology features: cracks are produced in the edge of acid etching sample and at the junction of fine equiaxed grains and columnar products, and expanded internally along the columnar crystals.

Causes: crystallizer deformation, oversize local friction, inaccurate arc-alignment, uneven cooling of crystallizer and secondary cooling zone, continuous casting blank bulging and oversize straightening force.

Assessment principles: assessment is conducted according to the distance, the width, the length and the number of the cracks from the surface.

3.2.4.3 Middle cracks

Morphology features: Cracks are appeared in the columnar zone on acid turbid sample and expanded along the columnar crystal. The middle cracks of the arc-shaped continuous casting blank are perpendicular to the slab surface.

Causes: Due to uneven cooling, after leaving the secondary cooling zone, the surface temperature of continuous casting blank recovers and generates the thermal stress. In casting and straightening, the mechanical stress is too large. The development of columnar crystals also contributes to the occurrence of cracks.

Assessment principles: assessment is conducted according to the width, the length and the number of cracks.

3.2.4.4 Center cracks

Morphology features: Cracks that appear in the center of acid etching sample.

Causes: in the final period of continuous casting blank solidification, steel-liquid in the heart is solidified and shrunk to produce mechanical stress,

Morphology features: Clumps or particles of different colors and shapes are presented on the acid etching sample.

Causes: Tundish low liquid level pouring generates vortex to inhale slag into crystallizer, which is failed to float up and separate. Or because the liquid level fluctuation in the crystallizer is too large, the slag involving in the steel-liquid before coagulation cannot float up to form center slag. The slag near the surface of continuous casting blank is subcutaneous slag.

Record the size, the digit and the position of slag inclusion during the assessment.

3.2.4.9 Foreign impurity metal

Morphology features: The metal block of no certain shape presents different color and matrix on acid etching sample. Some have obvious boundaries with matrix, and some have no obvious boundaries.

Causes: because the added alloy materials or the plunged dissimilar metals are not completely melted before pouring.

During the assessment, record the size and the location of foreign impurity metal, and use microscopic examination to identify.

3.2.4.10 Skull patch

Morphology features: On acid etching sample, some present white curved bands with pores or inclusions on or around them; some present irregular dark lines; others are bands composed of dense holes and inclusions.

Causes: In pouring process, the liquid level fluctuation in the crystallizer is too large, or the insertion of nozzle is shallow, or the inclination is not appropriate, etc. So, the liquid oxide-film is rolled in the steel-liquid and fails to float up before solidification.

During the assessment, record the length and the position of skull patch.

3.3 Rating picture

3.3.1 According to the size of continuous casting blank rating, the pictures are divided into four categories; macro defects are generally divided into four grades; and unrated defects only list out the typical pictures.

3.3.2 Appendix A applies to the continuous casting blank with the side length between no less than 100mm and no more than 300mm, or the rectangular blank with the sectional area of no more than 90000mm^2.

Note: The actual size of the side length of rating picture is 100mm.

3.3.3 Appendix B applies to the continuous casting blank with the side length between more than 300mm and no more than 550mm, or the rectangular blank with the sectional area of no more than 90000mm^2.

Note: The actual size of standard rating picture sample is rectangular blank with 370mm × 490mm, and the side length of standard rating picture for laboratory use is 151mm × 200mm.

3.3.4 Appendix C applies to the continuous casting round blank with the diameter between no less than 90mm and no more than 350mm.

Note: Referencing to the standard rating pictures in Appendix A of YB/T 4149-2006.

3.3.5 Appendix D applies to the continuous casting round blank with the diameter between more than 350mm and no more than 1000mm.

Note: The actual size of standard rating picture sample is continuous casting round blank with the diameter of 600mm, and the standard rating picture for laboratory use is 120mm in diameter.

3.4 Assessment method

Assessment of various types of defects is limited to visibility (if necessary, observe with the help of no more than 10 times magnifier). Compare and assess the defects according to the severity of rating picture separately. When the severity is between the two adjacent levels, assess half a level. When assessing other sizes of continuous casting blank defect levels, they can be scaled down or enlarged according to each defect rating picture.

3.5 Qualified level

Whether all kinds of defects are allowed to exist AND qualified level of defects shall be carried out according to the provisions of the relevant product standards.

4 Test report

The test report should include the following:

a) Organization commissioned;

b) Steel designations;

c) The sample smelting number;

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