CHAPTER I

INTRODUCTION

1.1 Generality

Nowadays continuous casting has become the mainstay of the most modern steelmakers. The advantages of continuous casting in comparison to ingot casting are improved productivity, reduced energy consumption and reduced costs. Various continuously cast products are of high quality and with this technology a large range of steel grades can be produced. Although continuous casting process can be given the high productivity but crack formation inside strand casting may reduce quality of the product. The formations of cracks during continuous casting of steel are currently of major concern to the industry. Various types of cracks are observed in continuously cast slabs, blooms and billets. Internal crack is a kind of crack inside strand casting and occurs in a range of solidification temperature. This temperature range can be defined as mushy zone when liquid and solid phase co-exist. Moreover internal crack formation is

related to hot crack susceptibility of steel during casting. The term of hot crack susceptibility can be referred to the critical temperature range (ΔT) or between zero strength temperature (ZST) and zero ductility temperature (ZDT). The critical temperature range indicates hot crack formation inside strand casting. If this temperature range is extended, crack will occur easily. This temperature range is affected from operation factors such as strand deformation during passing a caster roll, intensity of water cooling and chemical composition of the steel grades. Below the solidification temperature range, hot ductility is a factor predicts hot crack formation of a strand. The term of hot ductility refers to the amount of hot deformation a material able to accommodate without fracture or severe cracking for each steel grade of different and depends on steel composition and casting conditions.

In case of high alloy steel or high carbon steels such as tool steel, it is often more difficult to cast continuously than to cast low alloyed or low carbon steel. High alloy steel often contains more surface and internal cracks than low alloy steel and often they also contain serious centerline segregation. In industry, soft-reduction is used to minimize centerline segregation and blowholes and is used to gradually reducing strand

thickness during solidification of the steel. The former manufacturing of tool steel is casting with ingot but the continuous casting process can give higher yield than the ingot casting.

To study hot crack susceptibility and hot ductility of these steel grades, it can be done with the help of hot tensile test under the condition similar to the continuous casting process. This test was done with continuous casting simulation machine at Institute of Ferrous Metallurgy and Material Science, Technical University of Aachen, Federal Republic of Germany.

1.2 Objectives

The objectives of this study were:

1) To measure hot ductility and critical temperature range under test conditions similar to those of soft-reduction during continuous casting the high temperature properties of two cold work tool steels, grade AISI L3 and AISI O1, between liquidus and 900°C.

2) To elucidate with additional metallographical investigations the phases that results in reduced hot ductility.

1.3 Scope

This study attempted to measure the critical temperature range (ΔT) and hot ductility of cold work tool steel grades AISI L3 and O1 which solidified with difference cooling rate from the liquid state. Then the specimens were tensile tested with difference strain rates until fracture. The fractured specimens were used to calculate reduction of area. To study the microstructure at a given tensile test temperature, the samples were quenched by a blast of argon. Data from hot tensile test and the microstructure of the specimen from hot tensile test and quenching test were analyzed to elucidate the cause of reduce hot ductility which finally resulted in hot cracking of the tested steel under the condition.

1.4 Expected benefits

The benefits, which were expected from this study, are as follows;

1) The results of hot tensile test under the condition similar to continuous casting process would be transfer to predict the critical temperature range that causes of hot crack susceptibility and to predict the

range of temperature which reduces hot ductility of the tested samples.

2) The testing would give clarify the cause and mechanism of hot crack initiation during continuous casting.