Proceedings of the 72nd World Foundry Congress
21-25th May 2016, Nagoya, Japan

Influence on the Fatigue Strength at Rare Earth content in the Spheroidizing agent

Shinsuke Nagaumi [1], Kazumichi Shimizu [1], Takafumi Funabiki [1], Kaito Todate [1] and Masato Shirai [2]
[1]Muroran Institute of Technology,
27-1, Mizumotocho, Muroran-city, Hokkaido, Japan, 050-8585
[2]Iwamizawa Imono. Co.,Ltd., 497-3, Yura, Kurisawa-cho, Iwamizawa-shi, Hokkaido, Japan, 068-0111

Mechanical properties of the spheroidal graphite cast iron are dependent on the spheroidized graphite. In the field of casting, rare earth (RE) is used in a spherical shape of the graphite. However, domestic production of RE has few, and rely on import. In this experiment, previous studied using a spheroidizing agent unified element other than RE as compared to the fabricated spherical graphite cast iron, RE test piece of spheroidizing agent in by performing a fatigue test the effect on me was investigated. Test piece the RE content of 0%, 0.3%, 0.5%, and with 1.0% of 4 kinds of smooth test pieces were subjected to fatigue tests by a plane bending fatigue tester. The results of fatigue test, fatigue strength was reduced by about 20-33% in the RE0% test pieces were compared with RE-containing test pieces. Result of cross-sectional observation of the fractured specimen by the test, the RE0% test piece inside a large casting defects are confirmed, the fatigue strength is significantly reduced was less affected by 0.3% to 1.0%.

Keywords: *Rare earth, Spheroidal graphite cast iron, Fatigue strength, casting defect, √area parameter.*

1. Introduction

Spheroidal graphite cast iron is widely used for automobile parts because it is excellent in mechanical properties, fatigue strength. Spheroidal graphite cast iron is known to graphitization nodularity exhibit good mechanical properties at 80%. Therefore, when producing spheroidal graphite cast iron by using a spheroidizing agent comprising a rare earth(RE) it has been attempted to improve the spheroidal graphite rate. However, RE is less production in Japan, and is dependent on imported from abroad, may become difficult to stably supplied. Therefore, development of a spheroidal graphite cast iron with a spheroidizing agent with reduced RE becomes a challenge.

A problem in the case of reduced RE content in spheroidizing agent is believed to affect the fatigue strength necessary for the strength member by a casting defects caused by thin part. In previous studies, RE content is reported to be a possible reduced to 0.3%. However, spheroidizing agents used are not uniform in composition, it believed that the influence of the elements might have occurred.

In this experiment, we produced a spheroidal graphite cast iron by using a spheroidizing agent unified element other than RE as compared to the previously used test pieces were subjected to fatigue tests. From the results, it was examined the effect of RE is on the test piece.

2. EXPERIMENTAL PROCEDURE

Test pieces shape, it was a flat plate shape of 120 × 40 × 5mm (Fig.1). We went a bending fatigue test. The test conditions were sinusoidal load repetition rate 20Hz. In fatigue test, the number of repetitions reaches 107 times, it was the load stress of unbroken of the test piece and fatigue strength σw. Test pieces fractured by the test, after sufficiently cooled at a temperature lower than the brittle-ductile transition temperature, was brittle fracture shocked. Specimens were separated by disruption was fracture observed using a scanning electron microscope (SEM).

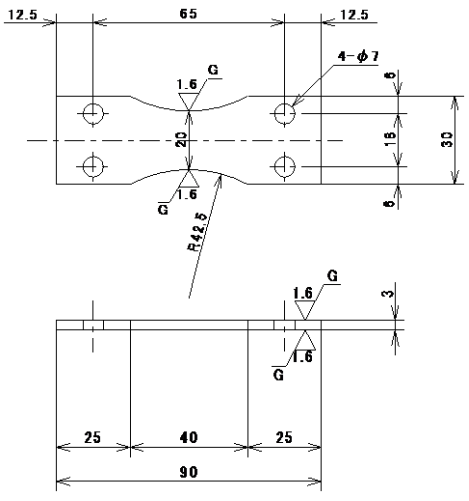

Fig.1 Test piece size

3. RESULTS AND DISCUSSIONS

Result of the tests were shown in Fig. 1. Test piece containing the RE0.3% was 321MPa, 0.5% was 287MPa, 1.0% was 306MPa, and 0% became 240MPa. RE content 0% test piece fatigue strength was reduced about 20 to 33% compared with the specimen containing the RE.

To investigate the cause of difference in the fatigue strength occurs for each test piece, the fracture surface observation was carried out using a scanning electron microscope (SEM). The SEM image of the entire fracture surface is shown in Fig. 3. Since a large casting defects were observed entirely in the fracture surfaces in the RE content of 0% of the test piece, it believed that lower significant fatigue strength occurs. Because the test piece containing the RE could not be confirmed is a large casting defects in the macro observation, we went the micro observation in the SEM. Result of the tests were shown in Fig. 4. Casting defects of about 100μm was confirmed in the test piece containing the RE. Investigate the effects of these casting defects have on the fatigue strength reduction, it was attempted to quantitatively evaluate that. Evaluation method is to organize the magnitude of casting defects of each test piece was evaluated in the stress intensity factor range that represents the strength of the stress field by using a √area parameter method (ΔK) and under critical stress intensity factor range (ΔKth).when ΔK its casting defects larger than ΔKth, it is a possibility to be the origin of the fracture. The results of measurement are shown in Table 1.The results are summarized in √area method, it showed no little difference in the value of ΔK / ΔKth.

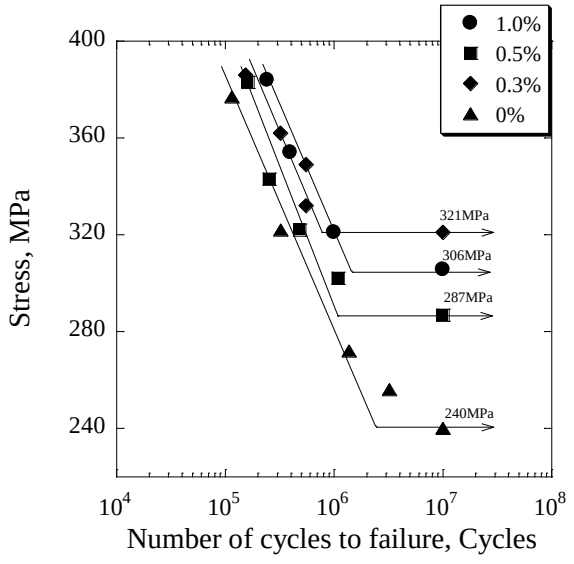

Fig. 2 S-N diagram.

Also, from the properties of the test piece, due to slightly higher nodularity-pearlite ratio and brinell hardness, as compared to other test pieces RE content 0.3% of the specimen is considered to fatigue strength is raised.

4. CONCLUSIONS

We investigated the cause reduced fatigue strength than the results obtained in the test.

1) RE content of 0% of the specimen as compared to the fatigue strength is reduced by about 20-33% and the test pieces containing the RE.
2) By adding the RE content of 0.3% or more of the spheroidizing agent, it can be assumed that it is possible to suppress a reduction in fatigue strength.
3) From the properties of the test piece, due to slightly higher nodularity and pearlite rate or brinell hardness, as compared to other test pieces RE content 0.3% of the specimen is considered to fatigue strength is raised.

References

(1) Nakae Hideo: new edition casting engineering 80, 2008, 149, Sangyo Tosho.

(2) Hideaki Nakayama, ZhaoBai-Rong, Kazuhiko Okada: casting engineering 84, 2012, 695.

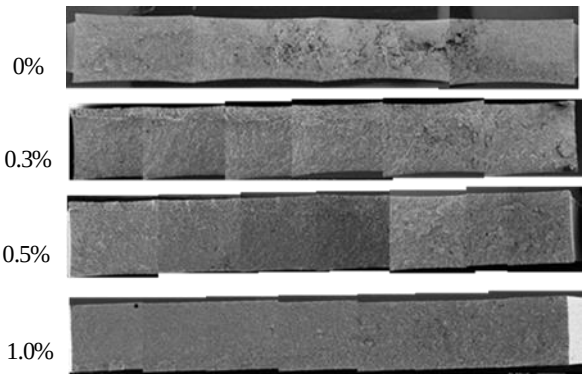

Fig. 3 Casting defect of fracture surface.

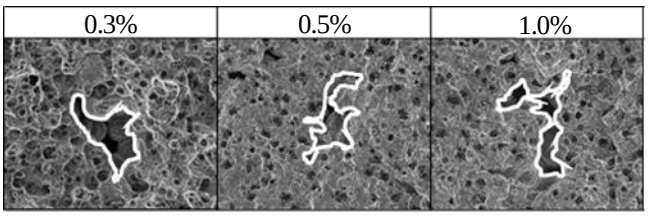

Fig. 4 Casting defect of fracture surface.

Table 1 Result of $\sqrt{area}_{max}$, ΔK and ΔK_{th}.

	Stress [MPa]	$\sqrt{area}_{max}$ [μm]	ΔK [MPa$\sqrt{m}$]	ΔK_{th} [MPa$\sqrt{m}$]	$\Delta K/\Delta K_{th}$
0.3%	332	206	8.45	6.76	1.25
0.5%	322	192	7.88	6.60	1.19
1.0%	321	218	8.39	7.21	1.17