KAWASAKI STEEL TECHNICAL REPORT
No.13 (September 1985)

Fatigue Properties of 50-kgf/mm2 High-Strength Hull Structural Steels Manufactured by Thermomechanical Control Process

Shigeto Matsumoto, Asao Narumoto, Chiaki Shiga, Syuzo Ueda

Synopsis :
Fatigue properties of newly developed steels with a tensile strength 50 kgf/mm2 (490 Mpa) grade, which are manufactured by Kawasaki Thermomechanical Rolling (KTR) and Multipurpose Accelerated Cooling System (MACS), are reported. The newly developed steels exhibit excellent weldability and low-temperature toughness. From the view point of fatigue strength, an investigation has been made on their fatigue properties in the through-thickness direction and on the softening of their high heat input welded joints. The relationship between the through-thickness fatigue strength and sulfur content only was obtained for KTR, MACS and conventional steels. There was no other factor which affects the through-thickness fatigue strength of newly developed steels. Reduction in fatigue strength due to the softening of HAZ was less than 15% when Kt was 1 and less than 10% when Kt was 3. Change in the value of m in Paris' formula due to the softening of HAZ was predicted to be 0.2, which was negligibly small. Base metal and high heat input welded joints of newly developed controlled rolled steels revealed excellent fatigue properties.

The body can be viewed from the next page.

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2 Materials and Experimental Procedure

2.1 Materials

Steels with a yield point of 36-kgf/mm^2 (353 MPa) class produced by the MACS-ACC (hereinafter called

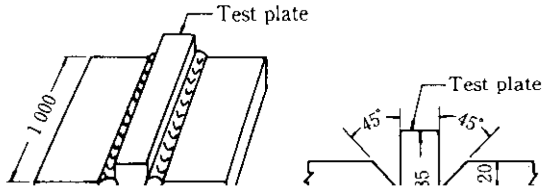


Table 2 Mechanical properties of materials

Process	Steel		Thick-ness (mm)	Direc-tion	*YP* (kgf/mm²)	*TS* (kgf/mm²)	*El* (%)
	M 1		25	L	38	52	35
				C	39	52	32

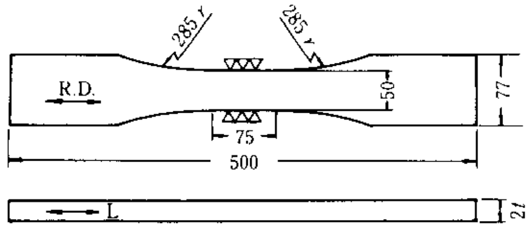
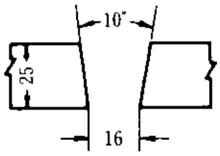
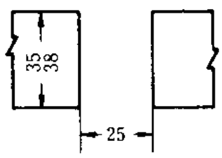
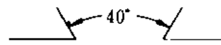


Table 3 High heat input welding conditions

Process	Steel	Welding method	Shape of groove	Welding current (A)	Arc voltage (V)	Travel speed (cm/min)	Heat input (kJ/cm)
MACS	M 1	EG		660	30	7.2	165
	M 2	CES		500	40	1.9	632
	M 3			510	32	2.0	490
MACS	M 4			1 450	33		

where

[illegible]

ρ: Notch radius
θ: Flank angle
h: Reinforcement height
$2T$: Plate thickness + $2h$
$2t$: Plate thickness

3 Test Results

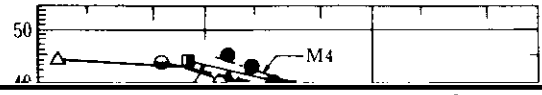
[illegible]

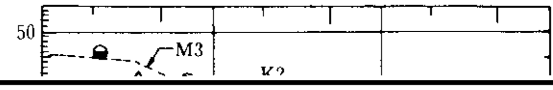
test and HAZ tensile test conducted on each type of [illegible]

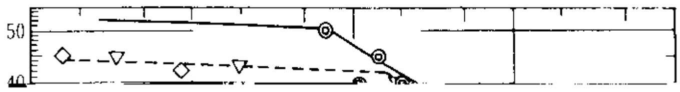
fractured in the base metal, and the increase in strength was small. In the HAZ tensile test, however, a maximum decrease in strength of 8 kgf/mm^2 (78 MPa) was observed.

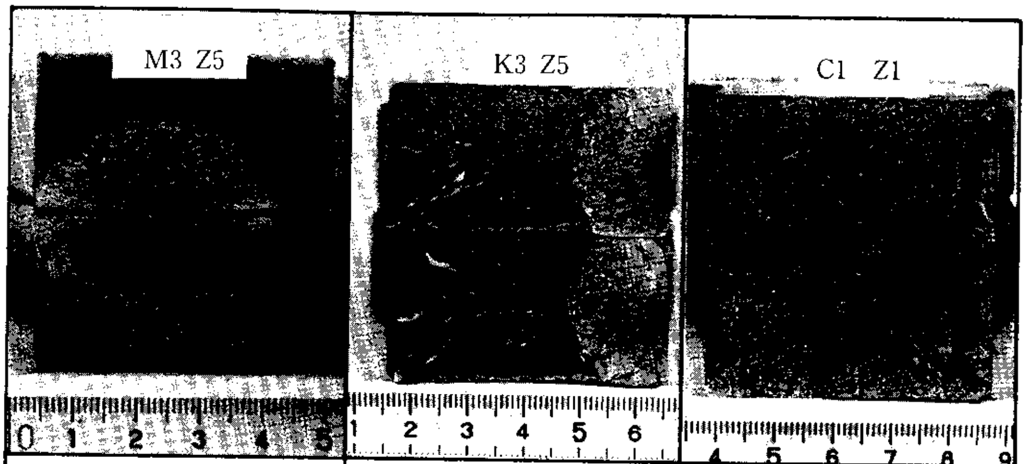
3.2 Hardness of High-Heat-Input Welded Joints

Table 5 gives the hardness of the most softened part of the HAZ and the width of the softened part as deter- [illegible]


50
M4


50
M3


50
40



$\sigma_B = 35.8$ kgf/mm²

[redacted]

[redacted]

[redacted]

[redacted]

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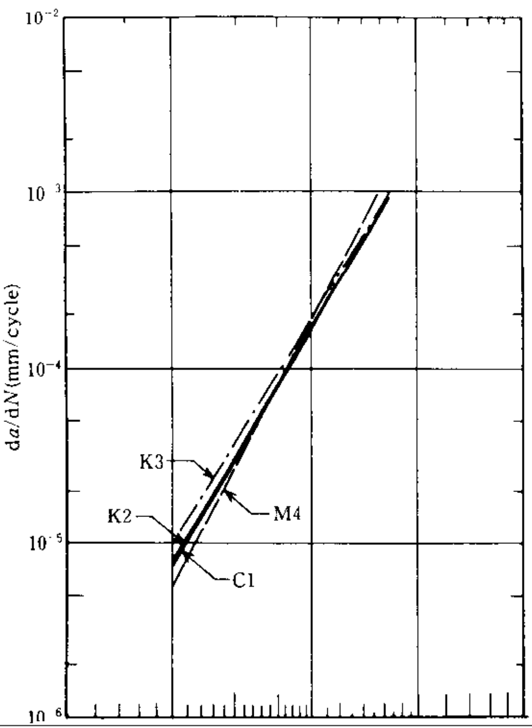
[redacted]

[redacted]

[redacted]

Photo 2 Fracture appearance of through-thickness fatigue specimens

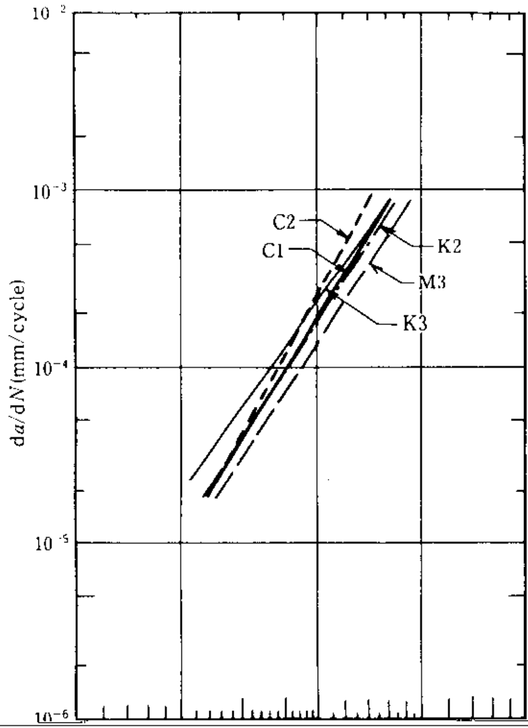


[redacted]

ΔK (kgf/mm$^{3/2}$)

Fig. 8 Relationship between fatigue crack propagation

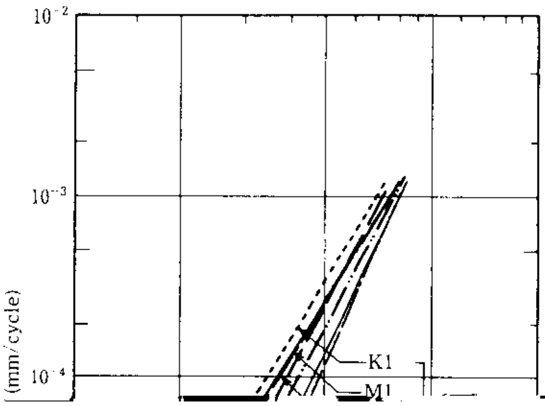
[redacted]



ΔK (kgf/mm$^{3/2}$)

Fig. 9 Relationship between fatigue propagation rate,

[redacted]


10^-2
10^-3
10^-4
(mm/cycle)
K1
M1

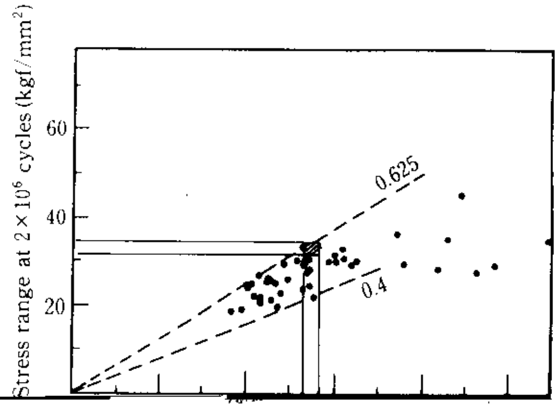
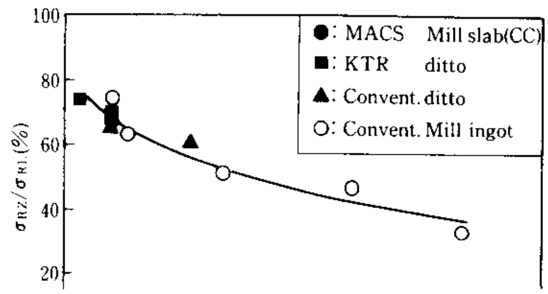

Stress range at 2 × 10^6 cycles (kgf/mm^2)
60
40
20
0.625
0.4

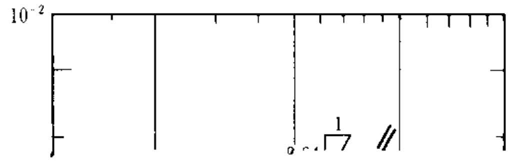
Table 8. Comparison of measured and

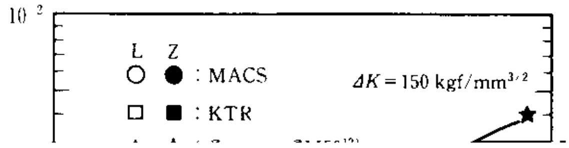


the material constant C and m, and that this equation holds for steels ranging from mild steels to high-strength steels.

$$C = A/B^{m} \qquad \cdots\cdots(10)$$

According to a report[12], $A = 2.14 \times 10^{-4}$ and $B = 99.7$. **Figure 15** shows this relationship together with the results of experiments with the present TMCP steels and conventional steels. Results obtained from the


10⁻²
1


10⁻²
L Z
: MACS
: KTR
ΔK = 150 kgf/mm^3/2

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