

REPORT N° 333
DATE: 14 FEBRUARY 1991
PROJECT: SC 90.02

MATERIAL TESTING

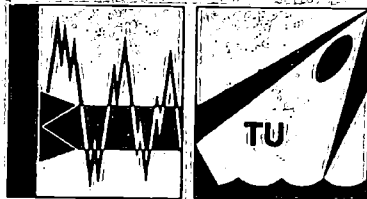
CTOD TESTS ON:

local pipe specimens

material: API 5L X60

DELFT - 14 FEBRUARY 1991

ING. RUUD VONK



SHIP STRUCTURES LABORATORY.

CONTENTS

page

1. Introduction.	1
2. Material and specimens.	1
3. Precracking and bend tests.	1
4. Results.	2
5. Table and graphs.	3-6
6. Calibration data of MTS clip gauge.	7

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1. INTRODUCTION

This report gives the CTOD-values for one set of three specimens tested at -10°C in accordance with BS 5762:1979.

The tests have been carried out on request of the Apparaten- en Ketelfabriek AKF BV in Goes on behalf of AKF-order no. 31706/6.

2. MATERIAL AND SPECIMENS

According to the information from AKF the specimens are taken from bended pipe material.

Material: API 51 * 60.

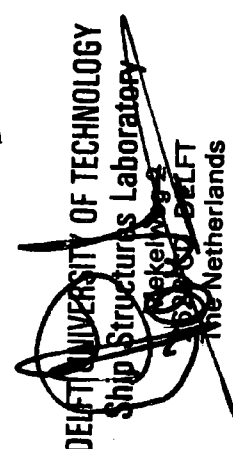
Form : \varnothing 406.4 mm * 31.75 mm. Radius 1219 mm.

Heat no.: G 6676 E.

Specimens 39: external axis - bend area -
transverse base material.

The specimens are supplied by Nieuwstraten Proefstaven BV in Poeldijk.

Specimens size: B = 25 mm. W = 25 mm.
Machined notch = 5 mm.



3. PRECRACKING AND BEND TESTS

Precracking and bend tests have been carried out in 3-point bending, in accordance to BS 5762:1979.

A 100 kN load-controlled servo-hydraulic testing machine has been used for the realisation of the fatigue precracking under constant amplitude loading at room temperature.

The CTOD-tests have been carried out in a 350 kN load-controlled servo-hydraulic testing machine with a cryogenic box. Cooling and stabilisation on the test temperature is obtained by accurately controlled liquid nitrogen injection through a solinoid valve. Via a ducting system the nitrogen is distributed homogeneously in the cryogenic box, without influencing the measuring devices.

The temperature is measured using thermocouples in contact with the test piece near the crack tip location.

The test temperature for all specimens has been -10°C . The tests were started at a temperature of about 1°C below the test temperature. Depending on the amount of plastic deformation the measured temperatures rose to a value between -10°C and -9.5°C at

the moment of failure.

The COD's have been measured with a MTS clip gauge, type 632.020-20, serial no. 675. The calibration values over ranges of 0.5 and 2.6 mm are given on page 7.

4. RESULTS

The results are presented in the table and graphs on page 3 up to 6.

All tests are valid according to BS 5762:1979.

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FRACTURE MECHANICS TEST (CTOD-test) cf. BS-5762-1979

PROJECT SC 90 02

Date: 14 febr 91

CLIENT: Apparaten en Ketelfabriek A.K.F. BV - Goes

Specimen data

Specimen nr		512391	512392	512393
W (height)	(mm)	25.40	25.00	25.00
B (thickness)	(mm)	25.00	25.00	25.00

Fatigue precracking data 3 point bending

Testing machine	(kN)	100	100	100
Test temperature	(°C)	20	20	20
Span	(mm)	100	100	100
Loading	(kN)	24.0	24.0	24.0
R (stress ratio)		0.1	0.1	0.1
Kf (Nmm-3/2)		1179	1275	1266
Number of cycles (*10 ³)		30.95	28.17	27.94
a0	(mm)	7.9	7.5	7.3
a4	(mm)	7.4	7.8	7.9
a1	(mm)	8.3	8.6	8.4
a2	(mm)	7.9	8.5	8.6
a3	(mm)	7.7	8.0	7.9
a average / W		0.31	0.33	0.33

COD-test data 3 point bending

Testing machine	(kN)	350	350	350
Test temperature	(°C)	-10	-10	-10
Span	(mm)	102	102	102
dK/dt (N mm-3/2 s-1)		51.9	54.4	54.3
Vi	(mm)	---	---	---
Vc	(mm)	---	---	---
Vu	(mm)	---	---	---
Vmax	(mm)	2.030	1.820	1.920
Pi	(kN)	---	---	---
Pc	(kN)	---	---	---
Pu	(kN)	---	---	---
Pmax	(kN)	58.5	57.0	59.0

Calculated results

CTODi	(mm)	---	---	---
CTODc	(mm)	---	---	---
CTODu	(mm)	---	---	---
CTODmax	(mm)	0.993	0.857	0.910

Yield strength used in calculations: 413 N/mm²REMARKS valid valid valid

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test specimen V₂ 512.39/3

test temp, $t_{\text{test}} = -9,8^{\circ}\text{C}$

date 14 febr. '91

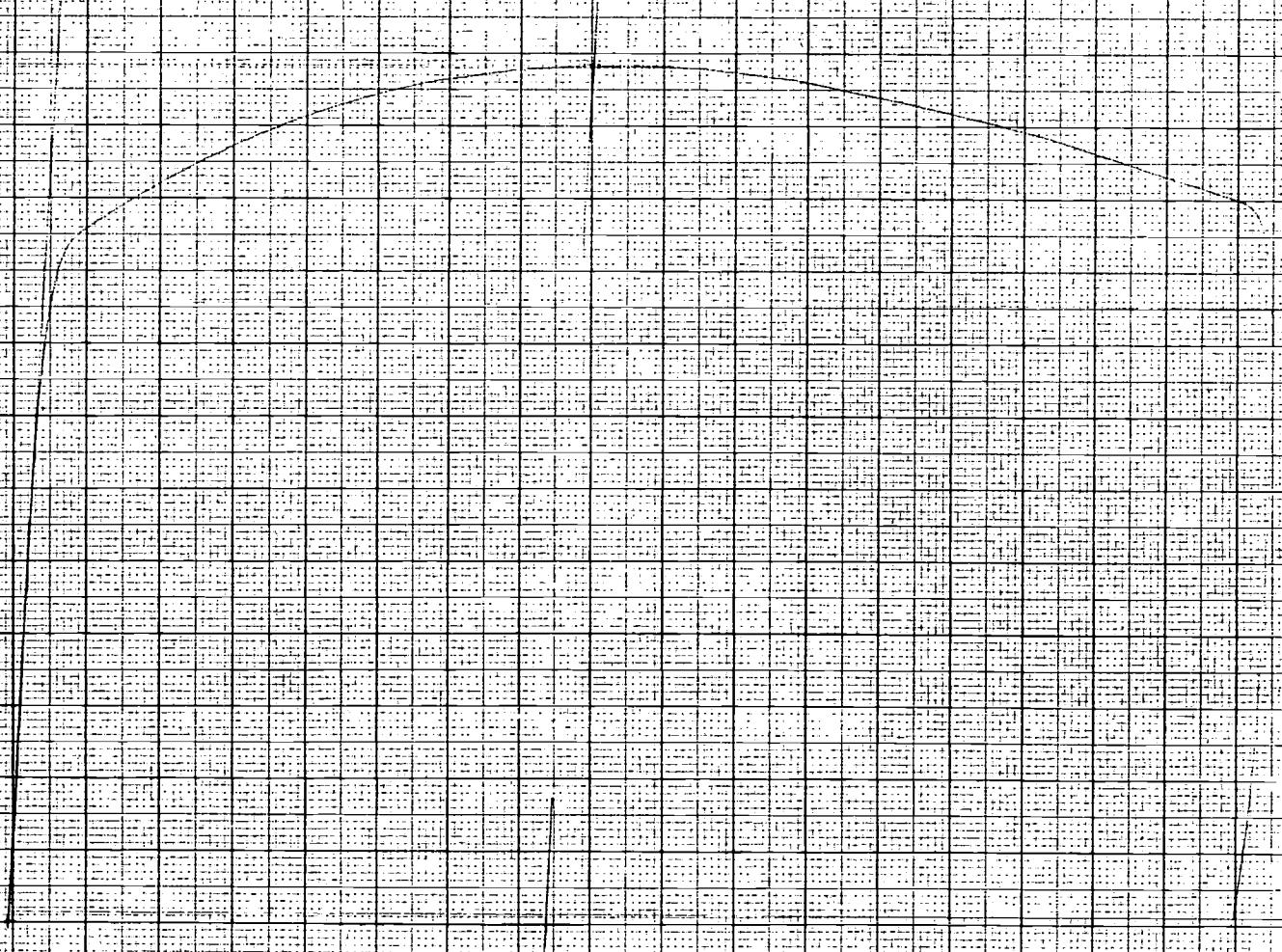
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$$P_{\text{max}} = 11,8 \times 5,0 = 59,0 \text{ kN}$$

$$V_{\text{max}} = 9,45 \times 0,859 = 8,11 \text{ kN}$$

5,0 kN \approx 1,0 cm

P



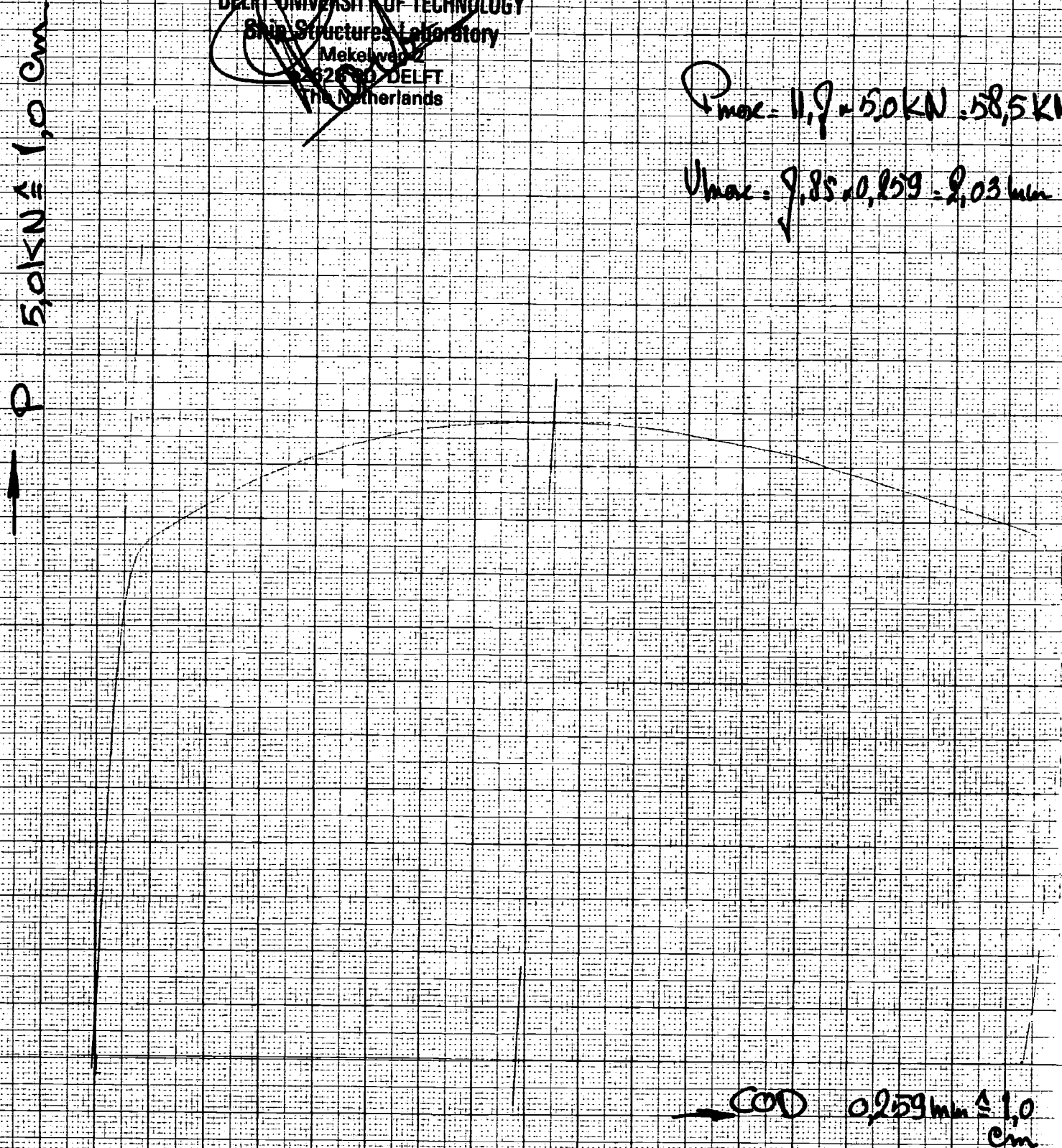
COD 0,859 mm \approx 1,0 cm

test specimen 1st 51239/1
 test temp $-9,9^{\circ}\text{C}$
 date 14 jan 1991

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$$P_{\max} = 11,7 \times 5,0 \text{ kN} = 58,5 \text{ kN}$$

$$U_{\max} = 7,85 \times 0,059 = 0,463 \text{ mm}$$



test specimen nr 512 39/2
 test temp / $t_{\text{test}} = -9,8^{\circ}\text{C}$
 date 14 febr '91

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$$P_{\text{max}} = 11,4 \times 5,0 = 57,0 \text{ kN}$$

$$V_{\text{max}} = 9,05 \times 0,959 = 1,82 \text{ kN}$$

P
 $5,0 \text{ kN} \leq 1,0 \text{ cm}$

P

$\text{COD } 0,259 \text{ mm} \leq 1,0 \text{ cm}$

Calibration of MTS clip gauge 2.5 mm

Clip gauge type: MTS 632-02C-20

Serial number: 675

Measuring range: 2.5 mm

Gauge conditioner: Peeke MCA100 in 5000 microV/V range (f.s. 10V)

Calibration device: LSC microspan

Clock gauges: 0 - 0.5 mm with 0.001 mm accuracy

0 - 2.5 mm with 0.01 mm accuracy

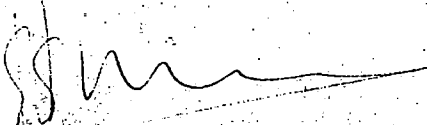
The clip gauge/conditioner combination has been calibrated on the 8th of February 1991.

The results are:

0 - 0.5 mm 1.916 Volts per mm, inaccuracy 0.004 mm, 1% of f.s.r.

0 - 2.5 mm 1.930 Volts per mm, inaccuracy 0.016 mm, 0.7 % of f.s.r.

Delft, February 12, 1991



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