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TECHNISCHE HOGESCHOOL – DELFT

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BETREFFENDE:

Comparison between static C.O.D.-tests and Niblink drop weight tests.

By Prof.ir. J.J.W. Nibbering.

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SSL 166

COMPARISON BETWEEN STATIC C.O.D.-TESTS AND NIBLINK DROP WEIGHT TESTS.

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Summary.

Static C.O.D.-tests according to the CODA-procedure (Nichols et al. /1/) have been carried out with Electroslag-, Electrogas- and Submerged-arc-welds. (See table I and figures 1 and 2).

In order to study size-effects, a number of static tests has also been carried out with specimens of the Niblink type. The results of the latter were generally somewhat more favourable than those of the former. (Table I and figures 1 and 2).

Niblink drop weight tests have been done for studying eventual relations between static and impact testing. The results are shown in figures 3, 4 and 5. It is worth noting that the scatter of the results of the drop weight tests is generally smaller than that of the static C.O.D.-tests. The comparison between both types of experiments is made in figures 6 a to g. (The dotted lines in the figure represent $COD_{dyn.} = COD_{stat.}$ as a reference).

Where possible the ratio between a residual C.O.D. of 0,06 mm at fracture (Niblink) and the static fracture C.O.D. at the same temperature has been given. It varies between 0,08 and 0,22 for 46 mm S.A. and 46 mm E.S. respectively.

Figure 7 shows Charpy-curves for some of the welds tested. A comparison between the 0,06 mm Niblink transition temperature, the 0,3 mm C.O.D. transition temperature and the 3,5 kgm/cm^2 Charpy transition is given in table II.* The Charpy and Niblink results correspond well, probably partly because both involve high speed loading. The static C.O.D.-results deviate over a range from 0 to 60°C. * Except for EG (B) 22 mm,

Finally in figures 6 d and e the "lower safe temperature" estimated from full scale fatigue tests at low temperature with cracks in the H.A.Z. is indicated. The corresponding ~~critical~~ fracture C.O.D.'s$_{static}$ are equal to 0,37 mm and 0,22 mm respectively. The ~~critical~~ fracture C.O.D.'s$_{dyn.}$ (residual) are 0,04 and 0,015 mm respectively.

It is worth noting that for the static C.O.D. test-results of 34 and 46 mm E.G.- and E.S.-welds, the value $\frac{\Delta \text{ COD}}{\Delta \text{ Temp.}}$ is rather small: 0,1/17° to 0,1/60° (see fig. 1 and 2).

Looking in conclusion to table III the correspondance between Charpy and Niblink results is ~~so~~ sufficiently good that it may be seen as a support to the Charpy-test! ~~For~~, Apparently all the well-known shortcomings of the Charpy-test (thickness, initiation + propagation energy instead of notch-deformation, notch acuity) do not appear in the results when a comparison is made with a test in which the mentioned shortcomings have been eliminated. It may be concluded that the large differences between the static C.O.D. and the dynamic tests have to be attributed mainly to the difference in loading type (static ↔ impact).

SUMMARY OF C.O.D. TESTS (STATIC LOADING).

Specim. No.	Thickn. in mm.	Specim.Type	Temp. °C.	Type of weld	Location of notch	Fracture load in tons	Fracture C.O.D. in mm.	Welding Data
ES1	46	NICHOLS	-35	ES	℄ WELD	15.0	0.167	Welding Electro Slag
ES2	"	"	0	"	"	17.7	0.213	POWDER-ESAB 10/50
ES3	"	"	-55	"	"	13.5	0.141	675A-46A
ES4	"	"	-52	"	"	18.0	0.280	WIRE TYPE
ES5	"	NICHOLS	0	"	1MM.HAZ	13.4	0.386	BHOLER NIMO1
ES-NB1	"	NIBLINK	-25	"	Fusionline	40.0	0.244	3 mm DIA.,
ES-NB2	46	NIBLINK	-50	ES	"	35.2	0.166	1% Ni, ½% Mo.
PD1	46	NICHOLS	-30	SA	℄ Weld	15.8	0.490	Welding Submerged.
PD2	"	"	-52	"	"	14.9	0.225	Arc. 4 Runs.
PD3	"	"	- 7	"	"	16.3	0.860	DOUBLE WIRE
PD4	46	NICHOLS	-31	SA	℄ Weld	16.8	0.690	1/8"DIA, SMIT No.29
PD-NB1	46	NIBLINK	-34	SA	℄ Weld	46.5	0.565	925A-38V
PD-NB2	46	NIBLINK	- 5	SA	℄ Weld	49.5	0.880	POWDER TYPE No. 50.
EG1	34	NICHOLS	-27	EG	℄ Weld	10.0	0.208	Welding Electro-GAS
EG2	"	"	- 1	"	"	11.0	0.520	AMOUNT OF CO_2
EG3	"	"	-28	"	"	10.1	0.120	30 L/MIN.
EG4	"	"	-49	"	"	8.5	0.140	600/625A-31V
EG5	"	"	- 4	"	1MM.HAZ	8.0	0.240	WIRE TYPE 2M/GY
EG-NB1	"	NIBLINK	-25	"	Fusionline	31.0	0.332	1/8" DIA.
EG-NB2	"	NIBLINK	-50	EG	"	29.0	0.280	
PD1	34	NICHOLS	- 4	SA	℄ Weld	10.4	0.350	Welding Submerged-
PD2	"	"	- 8	"	"	9.9	0.175	ARC. 4 Runs
PD3	"	"	-33	"	"	9.9	0.180	DOUBLE WIRE
PD4	"	"	-52	"	"	8.9	0.143	1/8" DIA, SMIT No.29
PD5	"	NICHOLS	-28	"	"	10.0	0.290	925A-38V
PD-NB1	34	NIBLINK	-33	"	"	38.7	0.355	POWDER TYPE No.50
PD-NB2	34	NIBLINK	- 6	"	"	37.8	0.305	
EGA1	22	NICHOLS	- 7	EG	℄ Weld	4.2	0.290	Welding Electro-GAS
EGA2	"	"	-32	"	"	4.5	0.720	WIRE NORMAL
EGA3	"	"	-31	"	"	5.7	0.660	CARBON TYPE
EGA4	"	"	-12	"	"	5.2	1.485	2,4 MM. DIA
EGA5	"	"	-28	"	Fusionline	4.3	1.150	σ YIELD 36 kg/mm^2
EGA6	"	"	-49	"	"	4.0	0.670	375A-38V.
EGA7	"	"	-33	"	1MM.HAZ	4.0	0.940	
EGA8	"	"	-50	EG	1MM.HAZ	3.8	0.440	
PDA1	22	NICHOLS	- 8	SA	℄ Weld	5.4	0.480	Welding Submerged-
PDA2	"	"	-26	"	"	5.3	0.290	ARC. 5 Runs
PDA3	"	"	-51	"	"	4.6	0.125	600A-34V.
PDA4	"	"	-40	"	"	5.2	0.190	σ YIELD SA WELD
PDA5	"	"	- 5	"	"	6.0	0.650	41,3 kg/mm^2.
PDA6	"	"	- 4	"	"	6.0	0.770	
PDA7	"	"	-31	SA	"	5.3	0.170	
EGB1	22	NICHOLS	- 4	EG	℄ Weld	3.5	0.085	Welding Electro-GAS
EGB2	"	"	-30	EG	"	4.0	0.360	WIRE SPECIAL
EGB3	""	"	- 5	"	"	4.0	0.525	LOW CARBON TYPE
EGB4	"	"	-32	"	Fusionline	3.8	0.095	2,4 MM. DIA
EGB5	"	"	-52	"	"	3.5	0.080	375A-38V.
EGB6	"	"	-33	"	1MM. HAZ	4.0	0.130	σ YIELD 33,4 kg/mm^2.
EGB7	"	"	-49	"	1MM.HAZ	3.7	0.105	
PDB1	22	NICHOLS	- 2	SA	℄ Weld	4.2	0.920	Welding Submerged-
PDB2	"	"	-30	"	"	4.3	0.352	ARC. 600A-34V
PDB3	"	"	-48	"	"	4.8	0.490	σ YIELD 53kg/mm^2.

TABEL 1

TYPE OF WELD	THICKNESS IN MM.	CHARPY 3.5 KGM/CM^2	NIBLINK TEST DYNAMIC 0.06 MM.	C.O.D.A.TEST STATIC 0.3 MM.
ES	46	+10° C	+ 20° C	+ 22° C
SUB. ARG.	46	—	- 4° "	- 46° "
EG	34	+13° "	+ 18° "	- 19° "
SUB. ARG.	34	—	+ 13° "	- 10° "
EG (A)	22	- 8° "	- 3° "	- 62° "
SUB.ARG.(A)	22	-18° "	- 13° "	- 23° "
EG (B)	22	+27° "	+ 27° "	- 24° "
SUB.ARG.(B)	22	+ 5° "	—	- 63° "

TABEL - 2

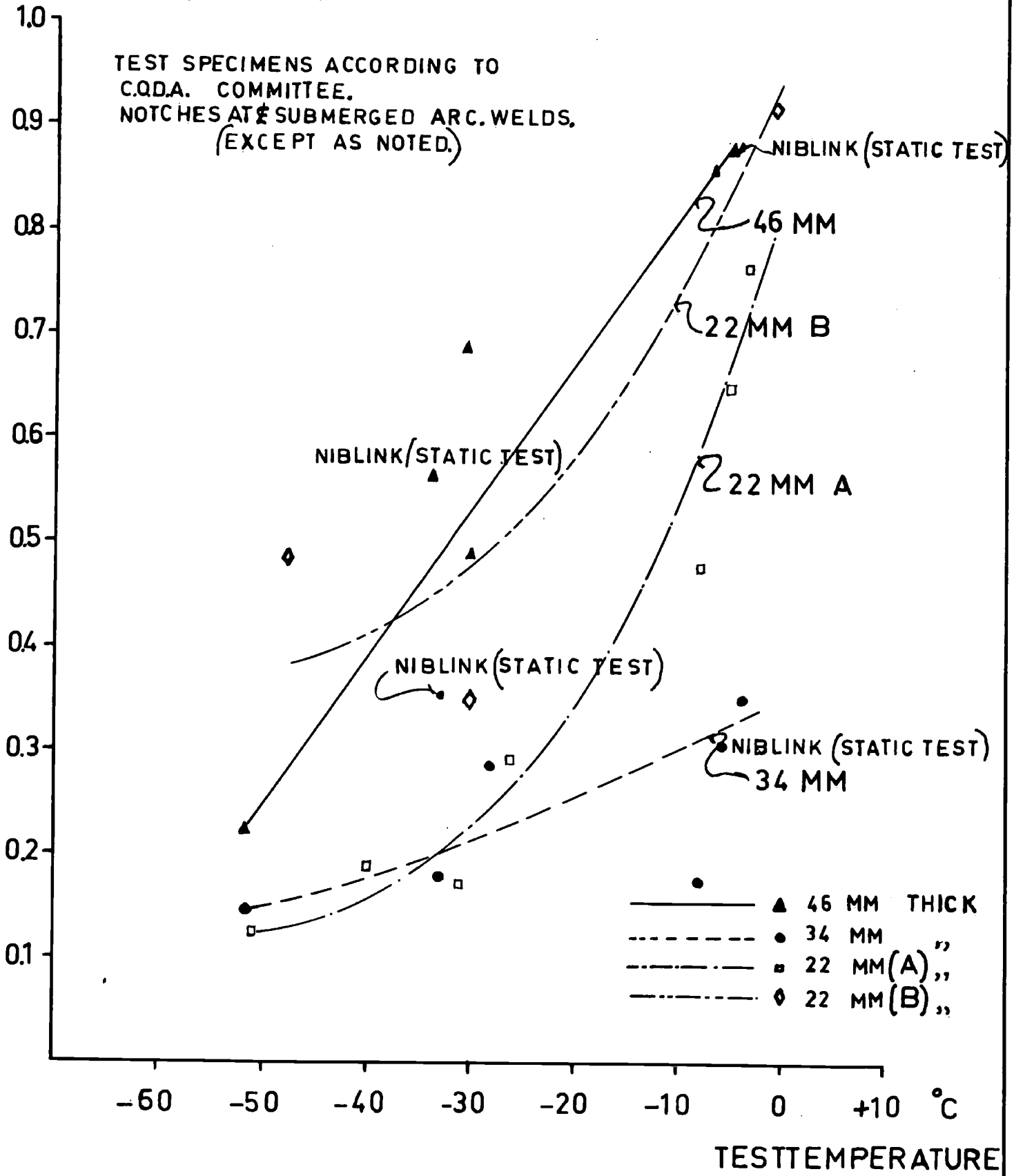
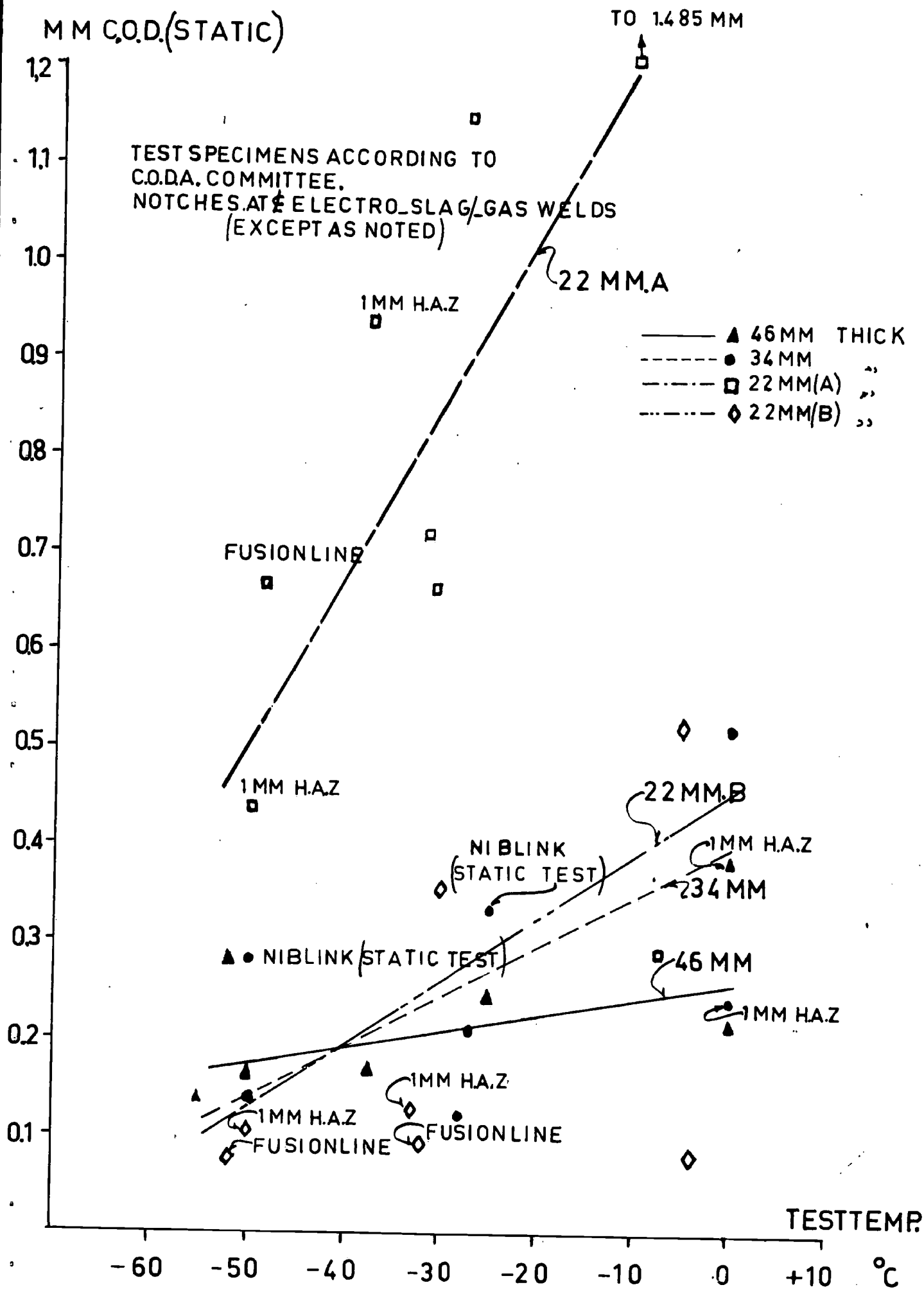


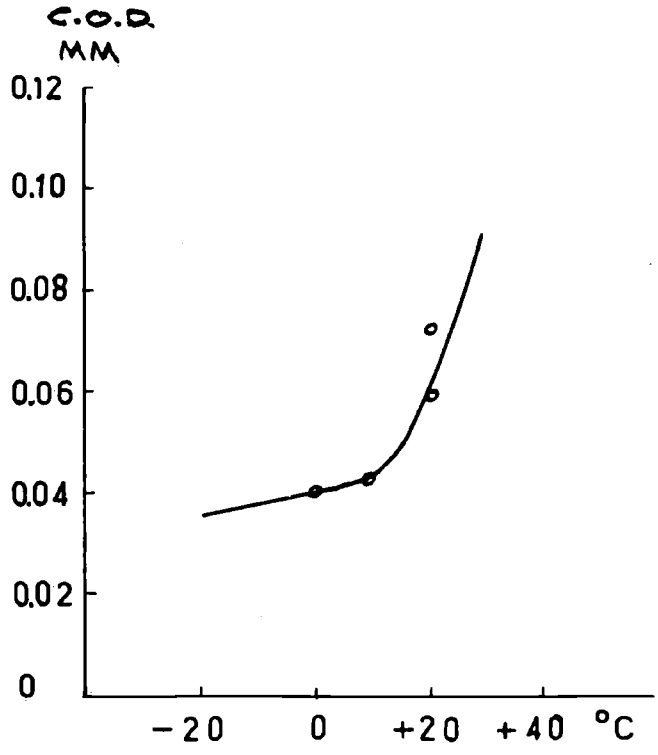
FIGURE 1 C.O.D AT FRACTURE VERSUS TEMPERATURE. SUBMERGED ARC. WELD

Bewerkingstekens volgens N 785	$2\tilde{5}=25\pm2$	$25=25\pm1$ $25=25\pm0{,}5$	$25{,}\bar{0}=25\pm0{,}2$ $25{,}\bar{0}=25\pm0{,}1$	$25{,}0\_=25\pm0{,}05$ $25{,}00=25\pm0{,}02$	$25{,}00=25\pm0{,}01$ $25{,}00=25\pm0{,}005$	SCHAAL :	
TECHNISCHE HOGESCHOOL LAB. v. SCHEEPSCONSTRUCTIES DELFT		BENAMING:			TEK. NO. SC. BLAD NO.	DATUM : GET. : FORMAAT:	A4



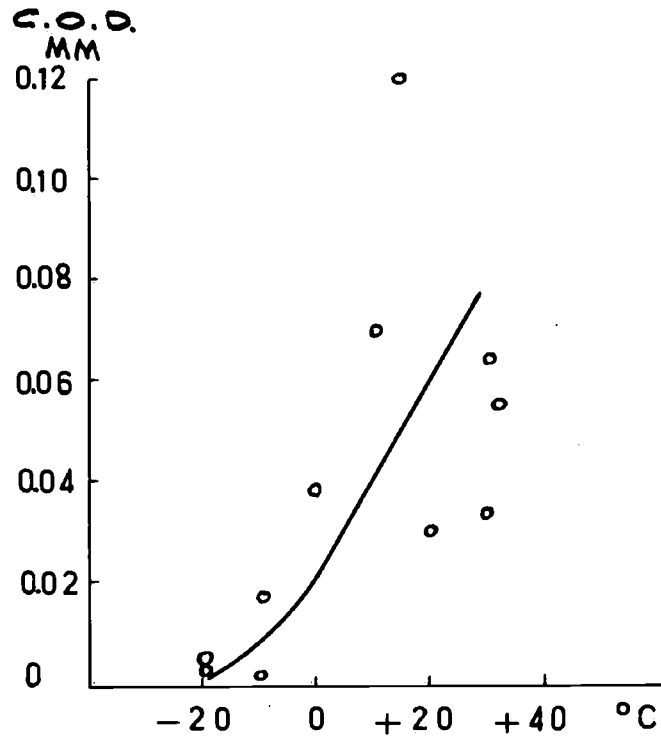
C.O.D AT FRACTURE VERSUS TEMPERATURE.

FIGURE 2 ELECTRO SLAG/- GAS WELD



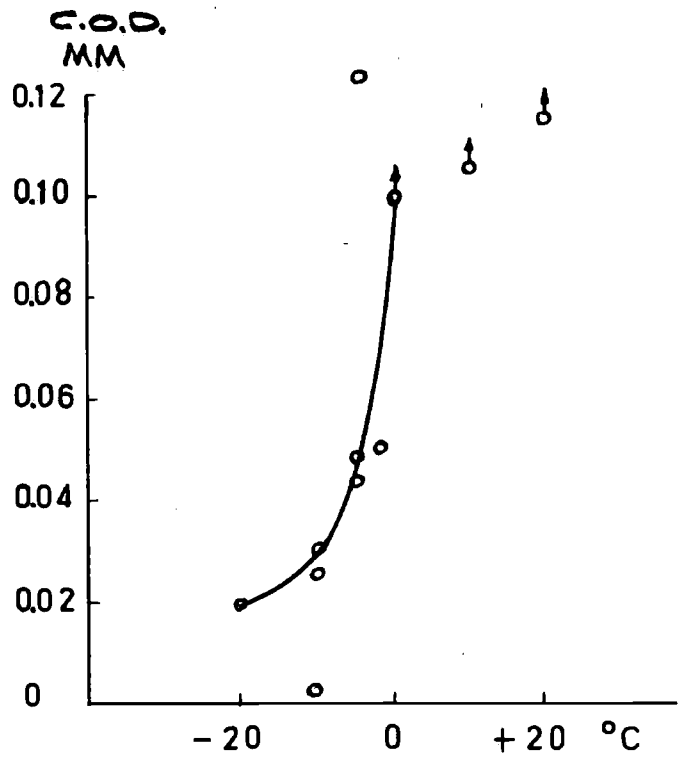
DROP. WEIGHT TEST 46MM E.S. WELD

FIG. 3A



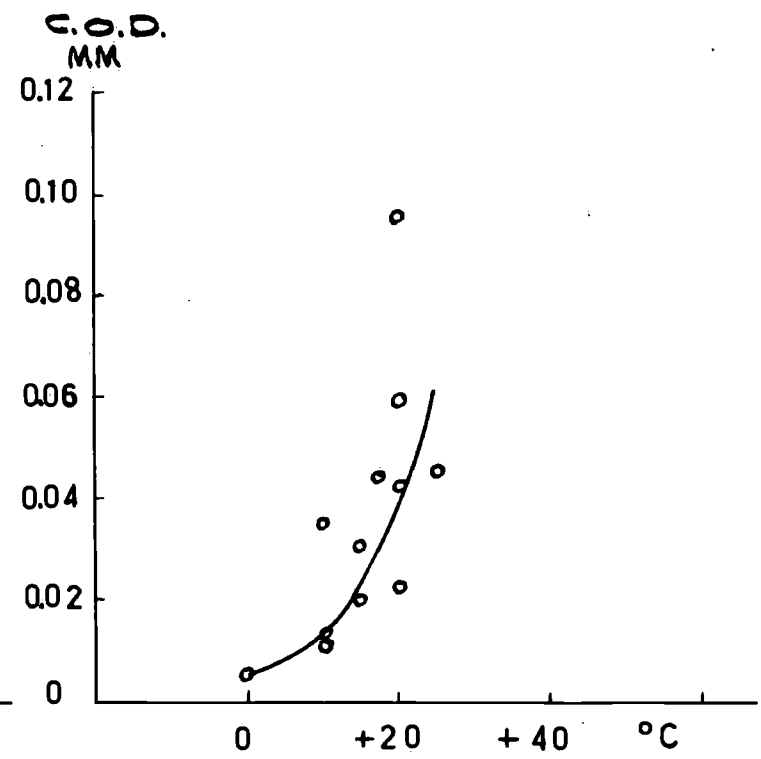
DROP. WEIGHT TEST 34MM E.G. WELD

FIG. 3B



DROP. WEIGHT TEST 22MM A EG. WELD

FIG. 4A

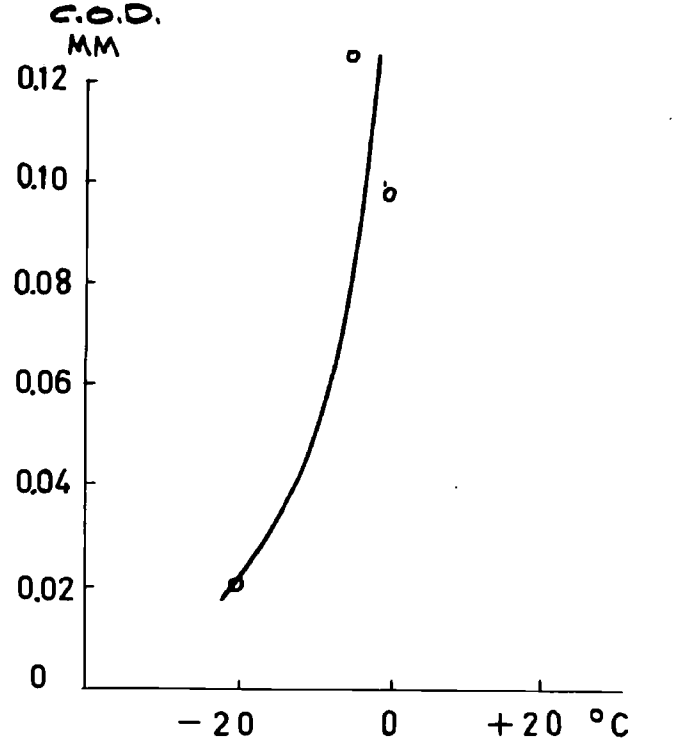


DROP. WEIGHT TEST 22MM B EG. WELD

FIG. 4B

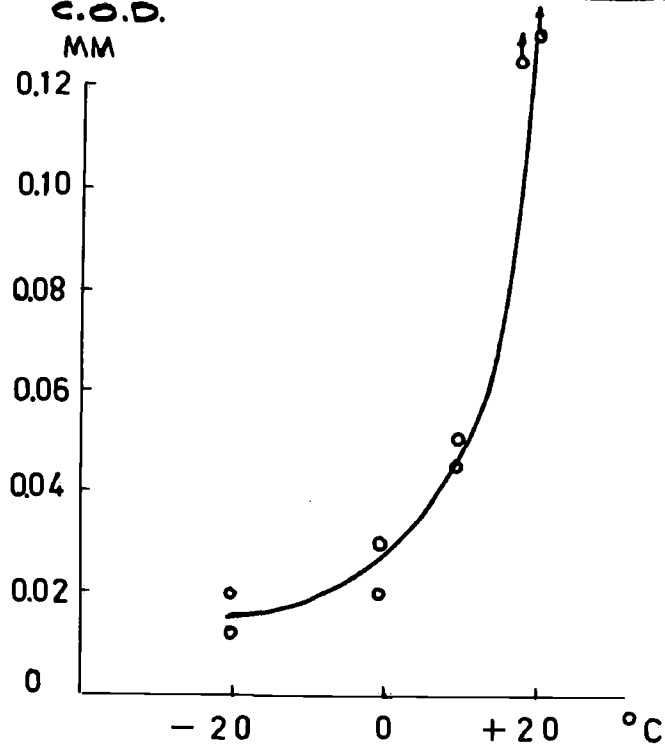
DROP. WEIGHT TESTS OF ELECTRO. SLAG/-GAS WELDS

FIGURE 3A, B. 4A, B.



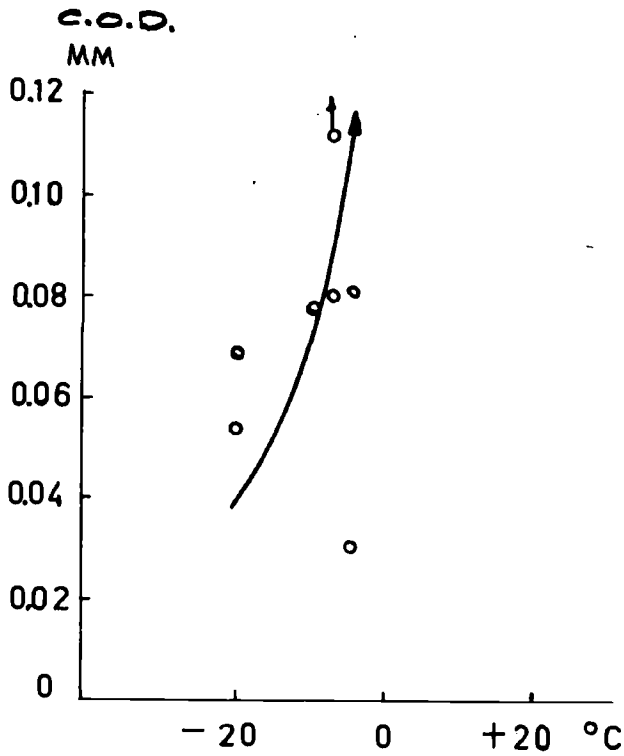
DROP WEIGHT TEST 46MM S.A. WELD

FIG. 5A



DROP WEIGHT TEST 34MM S.A. WELD

FIG. 5B

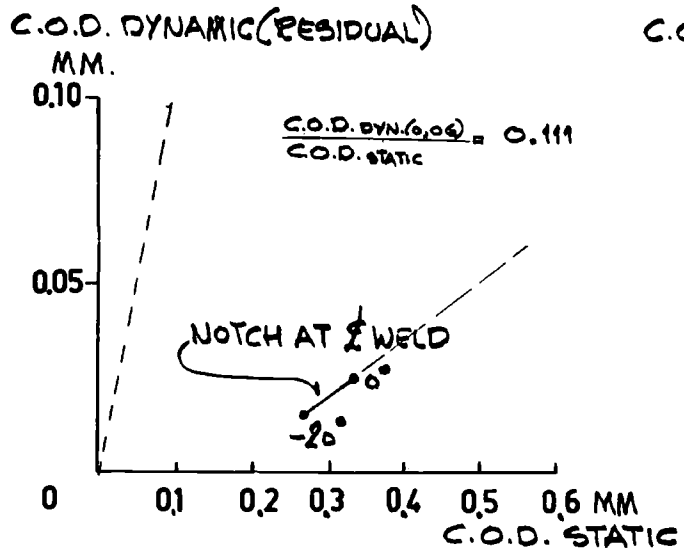


DROP WEIGHT TEST 22MM A S.A. WELD

FIG. 5C

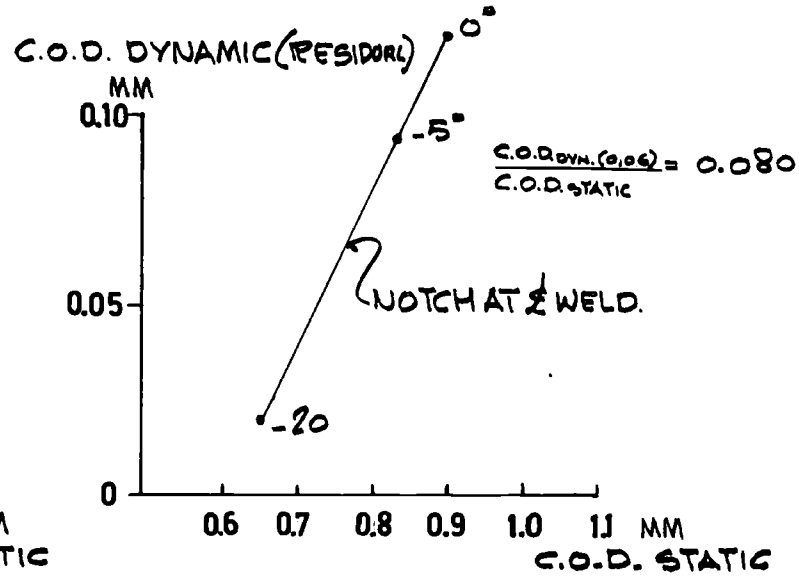
DROP WEIGHT TESTS OF SUBMERGED ARC. WELDS

FIGURE 5 A,B,C.



34 MM SUBMERGED ARC. WELD

FIG. 6A



46 MM SUBMERGED ARC. WELD

FIG. 6B

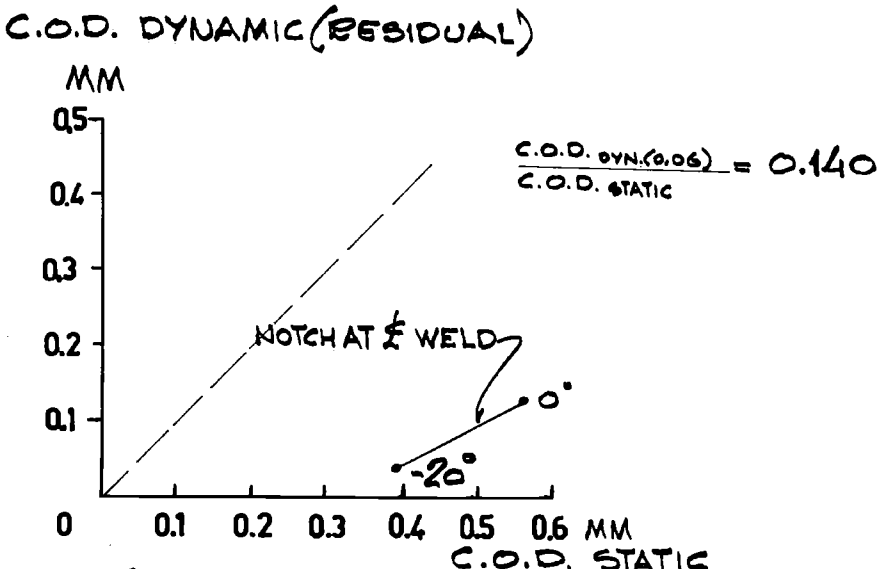
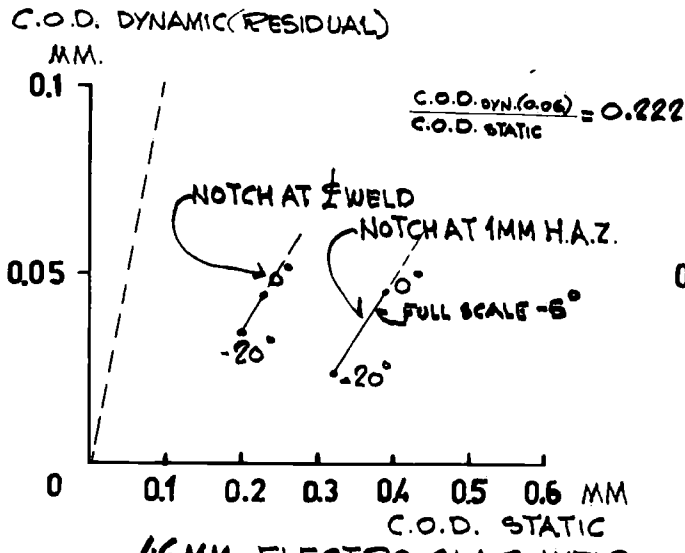


FIG 6C 22 MM QUAL. A SUBMERGED ARC. WELD

FIGURE 6A,B,C.

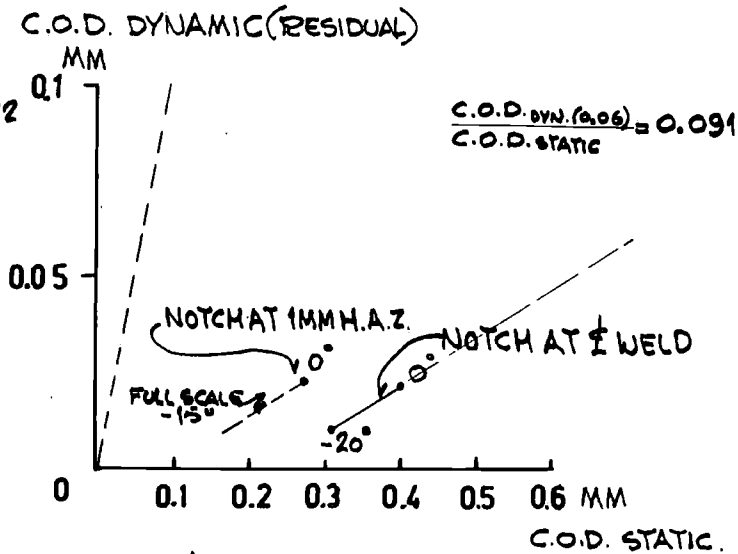
C.O.D. DYNAMIC (RESIDUAL) VERSUS C.O.D. STATIC

Bewerkingstekens volgens N 785	$2\tilde{5} = 25 \pm 2$	$2\bar{5} = 25 \pm 1$ $25 = 25 \pm 0{,}5$	$25{,}\bar{0} = 25 \pm 0{,}2$ $25{,}\bar{0} = 25 \pm 0{,}1$	$25{,}0\_ = 25 \pm 0{,}05$ $25{,}0\bar{0} = 25 \pm 0{,}02$	$25{,}00 = 25 \pm 0{,}01$ $25{,}00 = 25 \pm 0{,}005$	SCHAAL :	
TECHNISCHE HOGESCHOOL LAB. v. SCHEEPSCONSTRUCTIES DELFT	BENAMING:			TEK. NO. SC.	DATUM :		
				BLAD NO.	GET. :		
					FORMAAT:	A4	



46MM ELECTRO-SLAG WELD

FIG. 6D



34MM ELECTRO.GAS WELD

FIG. 6E

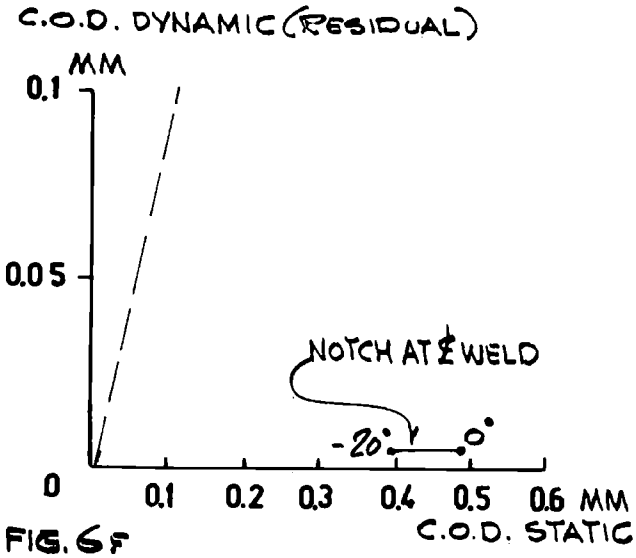


FIG. 6F

22MM QUAL.B ELECTRO.GAS WELD

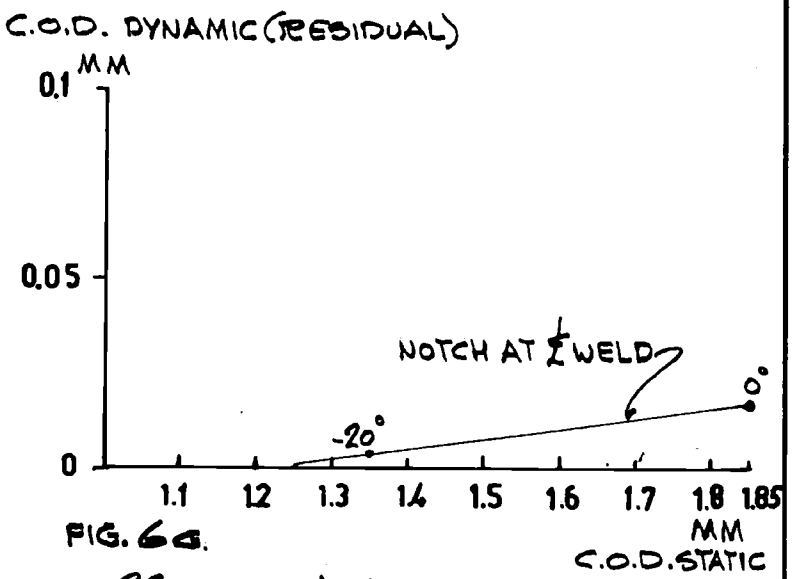
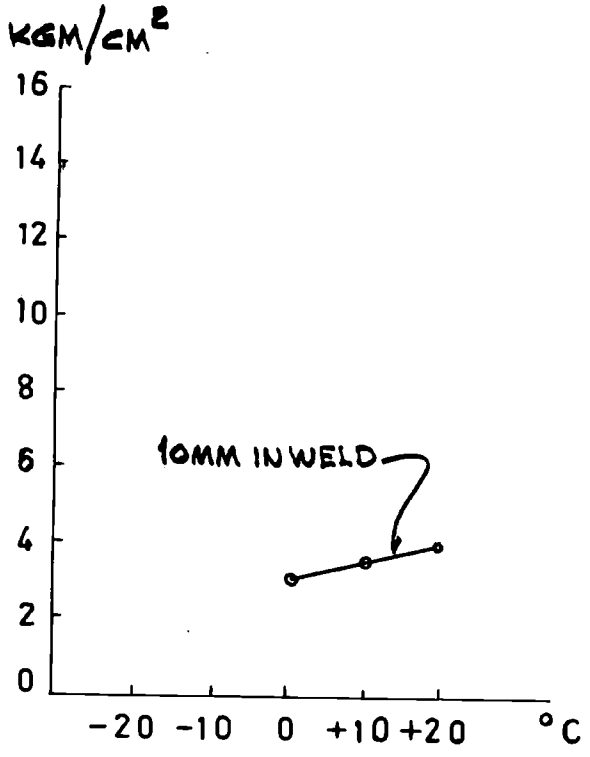


FIG. 6G.

22MM QUAL.A ELECTRO.GAS WELD

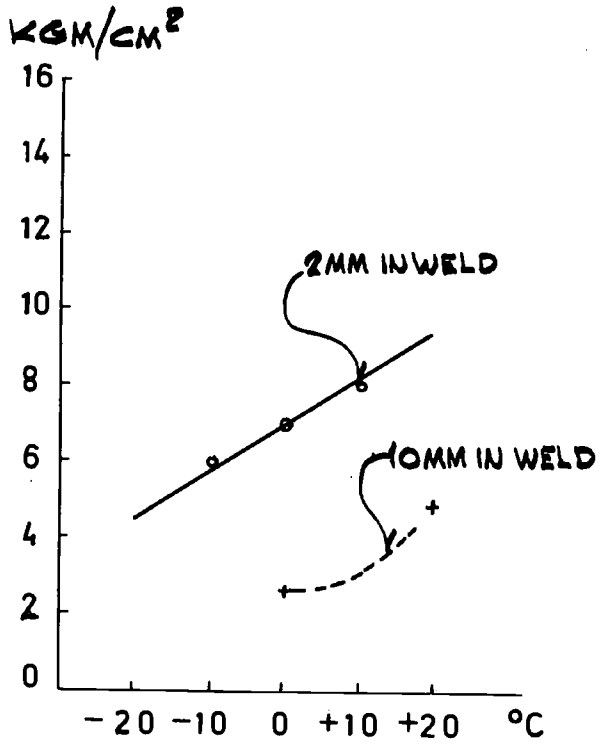
FIG 6 D t/m G. C.O.D. DYNAMIC (RESIDUAL) VERSUS C.O.D. STATIC

Bewerkingstekens volgens N 785	$25 = 25 \pm 2$	$25 = 25 \pm 1$ $25 = 25 \pm 0{,}5$	$25{,}0 = 25 \pm 0{,}2$ $25{,}0 = 25 \pm 0{,}1$	$25{,}00 = 25 \pm 0{,}05$ $25{,}00 = 25 \pm 0{,}02$	$25{,}00 = 25 \pm 0{,}01$ $25{,}00 = 25 \pm 0{,}005$	SCHAAL :	
TECHNISCHE HOGESCHOOL LAB. v. SCHEEPSCONSTRUCTIES DELFT	BENAMING:			TEK. NO. SC.		DATUM :	
				BLAD NO.		GET. :	
						FORMAAT:	A4



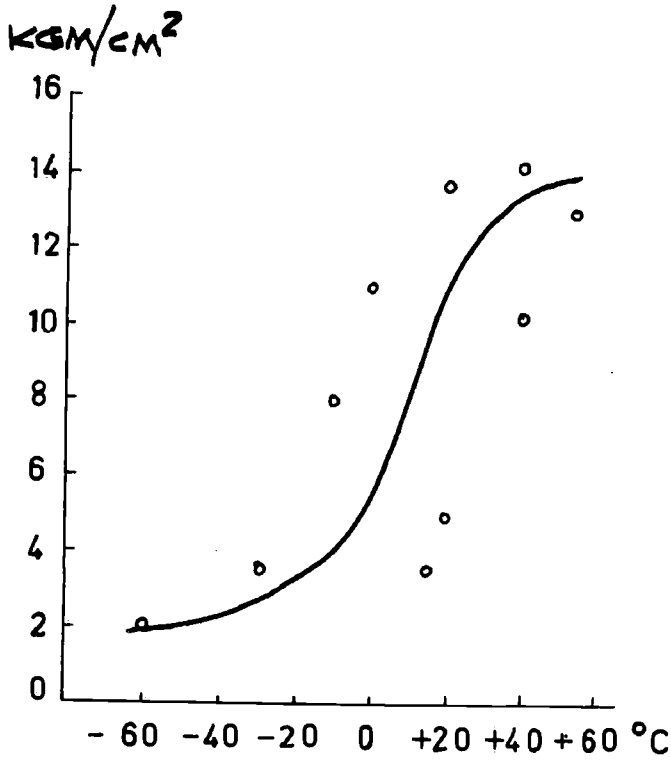
CHARPY-V VALUES OF 46MMES.

FIG. 7A



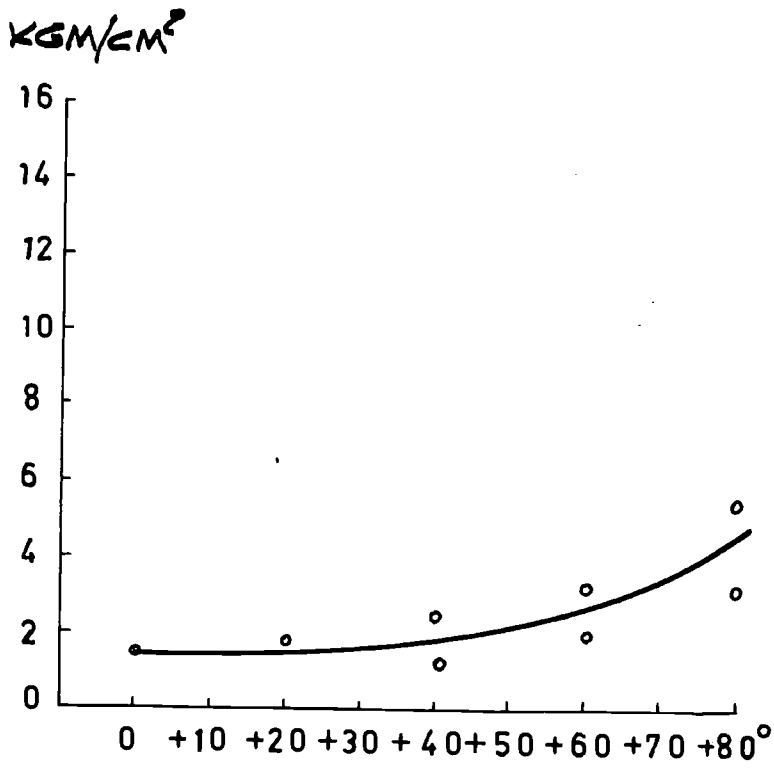
CHARPY-V VALUES OF 34MM E G.

FIG. 7B



CHARPY-V VALUES OF 22MM A EG.

FIG. 7C

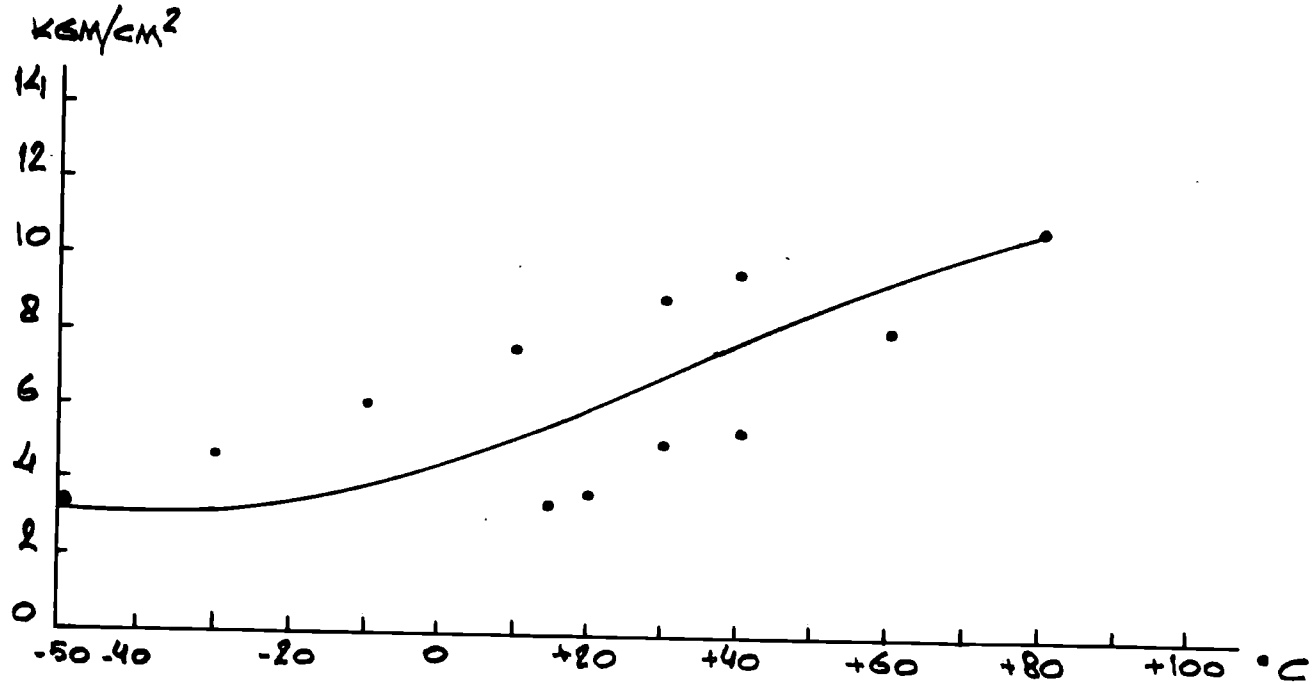


CHARPY-V VALUES OF 22MM B EG.

FIG. 7D

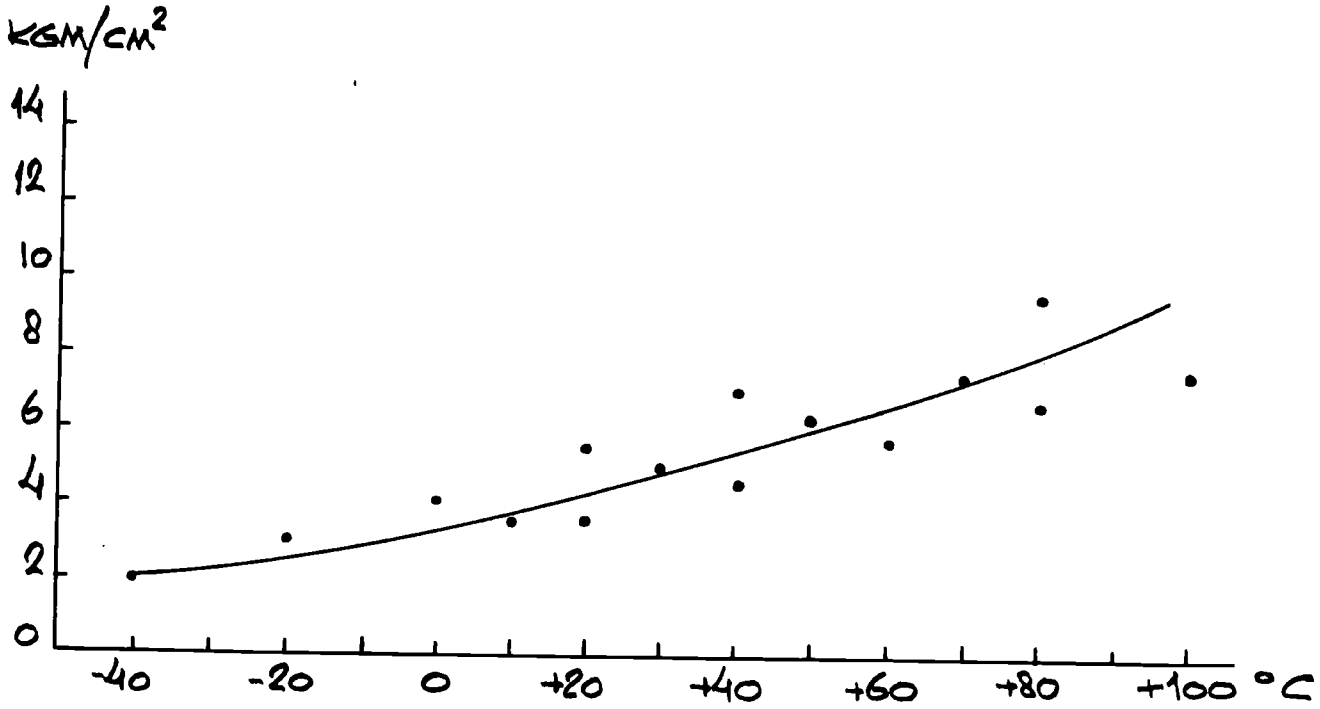
CHARPY-V VALUES OF ELECTRO-SLAG/-GAS WELD.

FIGURE 7A,B,C,D.



CHARPY-V VALUES OF 22MM A SUB. ARC. WELD

FIG. 7e



CHARPY-V VALUES OF 22MM B SUB. ARC. WELD

FIG. 7F

CHARPY-V VALUES OF SUBMERGED ARC. WELD

FIGURE 7 e, F.