FasdHTS **Contract: G3RD – CT 2000 - 00100**

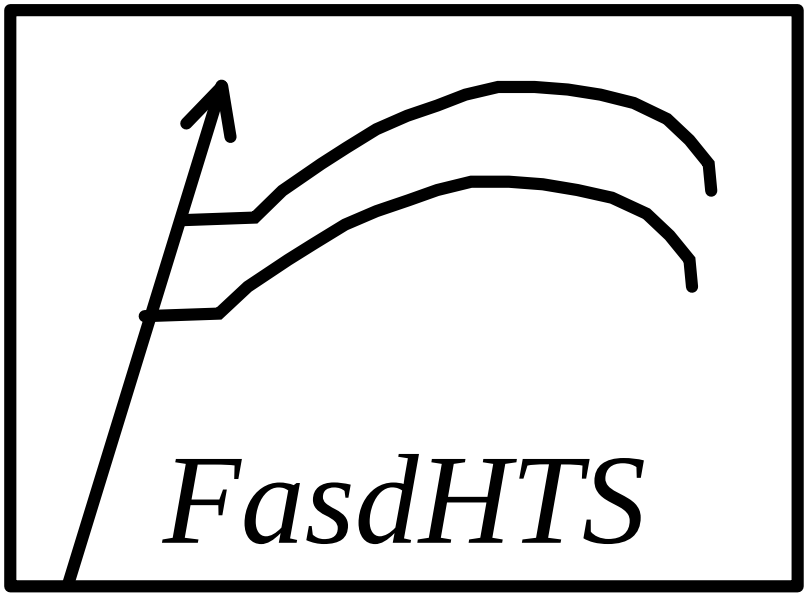
TD 02.32.02.02

Fabrication of the V butt welds Specimens
(Task 3.2)

LISNAVE
ESTALEIROS NAVAIS, S.A.

June 2002

Author : Jose Alexandre



AF – I	**BV**	**CAT**	**CTH**	**DH**	**FSG**	**GL**
GN	**TUHH**	**IST**	**LIS**	**RS**	**TNO**	

G3RD – CT 2000 – 00100 ***FasdHTS*** **TD 02.32.02.02**	FATIGUE BASED DESIGN RULES FOR THE APPLICATION OF HIGH TENSILE STEEL IN SHIPS

Doc. Ref.:	Date : 21 June 2002
TITLE :	**Fabrication of Specimens (Task 3.2)**
Author :	José Alexandre
Issued by :	LISNAVE Estaleiros Navais, S.A.

Summary:

This report describes the design and fabrication of the Specimens for V-butt Welds, using Extra High Strength Steels, S690Q in conformity with EN 10137-2. The yield strength of this material is at least 690 N/mm². Dillinger Hütte GTS supplied all the material for these specimens.

Revision	Date	Description	Pages	Checked	Approved
0	21-06-02	Draft		EM	CR
1	23-11-02	Final		EM	CR
2	14-02-03	Final	18	EM	CR

CONTENTS

1. Object

The fabrication of V-butt welds specimens for thinner plates are intended for testing with 4 mm plate specimens with L x W = 600 x 1200.

2. Steel

The steel was supplied by Dillinger Hutten Worke, according with certificates in Appendix I.

3. Photo 1 – Steel plates when arrival

A summary of the mechanical properties of the steel is given in Table 1 and of the chemical composition in Table 2.

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Identification mark	Steel			Heat No.	Plate No.
	Quality	Thickness	Grade		
1	DILL 690	4 mm	690 T	78874	91288
2	DILL 690	4 mm	690 T	78874	91289
3	DILL 690	4 mm	690 T	78874	91290
4	DILL 690	4 mm	690 T	78874	91291

Identification mark	Yield Stress N/mm^2	Tensile Strength N/mm^2	Elongation (%)
1, 2, 3 and 4	732	808	15

Table 1 – Mechanical properties

Identification mark	Steel		Chemical composition (%)									
	Qual.	Thick	C	Mn	Si	P	S	Cr	Ni	Mo	Al	B
1,2,3 and 4	690	4mm	0,184	1.36	0.268	0.010	0.008	0.034	0.025	0.006	0.016	0.001

Table 2 – Chemical comp osition

4. Preparation of specimens

The design proposed, as stated on document TD 01.51.01.01. Thinner plate thickness 4 mm.

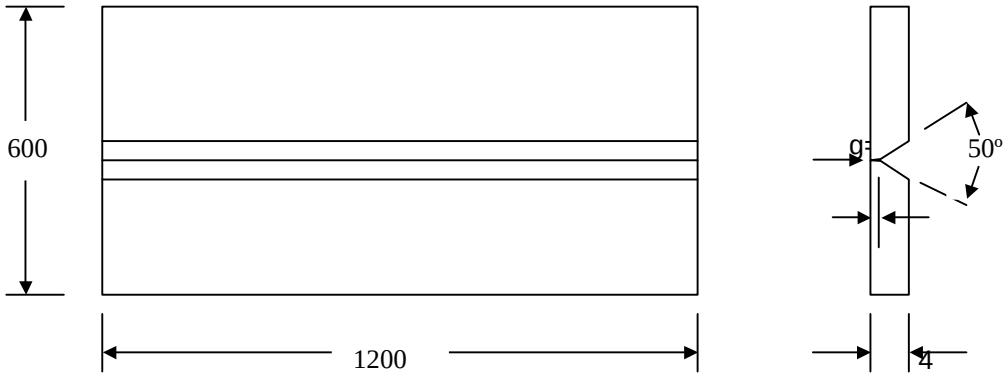


Fig.1 Welding preparation

Photo 2 – Welding preparation

The plates for the specimens were cut using steel cutting machine and grooves prepared by grinding, with an automatic machine.

To avoid plate distortion during the welding, the plates were supported by temporary reinforcements according with the sketch below (fig.2)

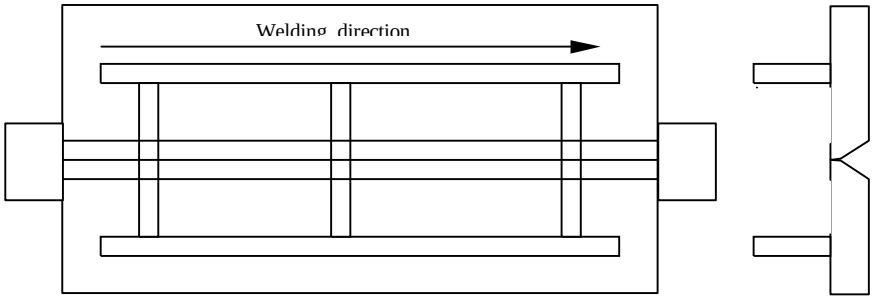


Fig. 2 Reinforcements to avoid distortion plate

After welding, the temporary reinforcements were removed, the surfaces were smooth by grinding and MPI was done to check for small cracks detection. No unacceptable indications were found.

5. Welding

An automatic machine carried out welding, as we can observe in the photos 3 and.4, using MAG process with constant current and flux-cored wire to weld the specimens. A rutile wire with a diameter of 1.2 mm was used for all the specimens.

Photo 3 – Automatic machine

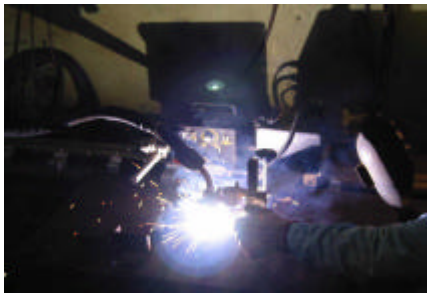


Photo 4 – Welding

The same welding process and wire was used for tack welding. The welding was done in the flat position (PA) for all specimens.
To prevent start and stop defects, run-on and run-off plates was used for all specimens as shown in photos 5 and 6

Photos 5 and 6 – The use of run-on and run-off plates.

6. Filler Metals: Chemical composition and mechanical properties.

The chemical composition is shown in table 3.

Designation	Chemical composition								
	C	Mn	Si	S	P	Cr	Ni	Mo	N
H.Fluxofill42	0.068	1.413	0.297	0.007	0.013	0.495	2.247	0.486	0.003

Table 3 – Chemical composition

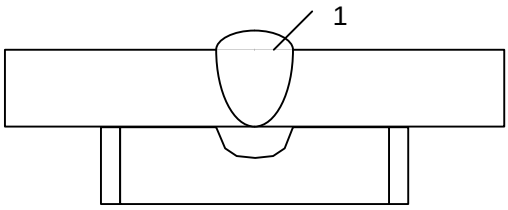
The mechanical properties are shown in table 4.

Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation (%)	Impact Strength (J)
699	782	18	12

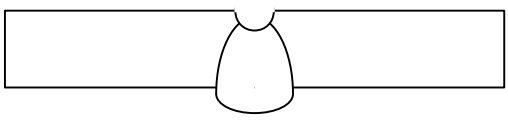
Table 4 – Mechanical properties

7. Welding sequence

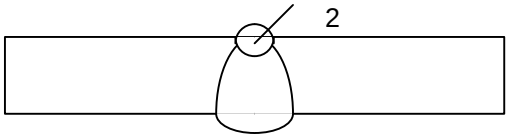
1 – Step : Face welding.



2 – Step : Grinding back side.



3 – Step: Back welding.



Photos 6 and 7 – Welding process and welding aspect

8. Welding Parameters

In table 5 is shown the welding parameters used for the specimens Model–A, without backing.

Weld Layers	Process	Filler Metal		Current		Volt Range	Travel Speed (cm/min)	Heat Input (Kj/mm)
		Class	Dia. (mm)	Type Polarity	Amp. Range			
1	Fcaw	AWS A5.29	1.2	+	229	23.6	40.3	0.80
2	Fcaw	AWS A5.29	1.2	+	229	23.6	43.1	0.75

Table 5 – Without backing

In table 6 is shown the welding parameters used for the specimens Model –B, with ceramic backing.

Weld Layers	Process	Filler Metal		Current		Volt Range	Travel Speed (cm/min)	Heat Input (Kj/mm)
		Class	Dia. (mm)	Type Polarity	Amp. Range			
1	Fcaw	AWS A5.29	1.2	+	229	23.6	31.57	1.03

Table 6 – With backing

9. Welding procedure specification

As the Yard has no experience in HTS 690 fabrication, the welding procedure specification (WPS) were developed and prepared with information obtained from DILLINGER HUTTE GTS, Technical Information No. I / 1998, in which are given some fabrication guide lines, such as:

Base metal characteristics:
Filler metals and consumables for welding DILLIMAX Steels.
Pre-heating temperature of 25ºC min. for thick. below 5 mm.
Inter-pass temperature 220ºC max.

No pre-heating was used to weld the 4 mm thickness plates.

The specimens were welded according with the welding procedure specification No. V.002, in Appendix I.

10. Non-destructive testing welds.

The first two, one intermediate and the last two specimens were 100% examined by X-rays, and no unacceptable indications were found.

11. Experiences

11.1. Preparation of the specimens

Differences were not found comparing to normal shipbuilding steel specimens preparation.

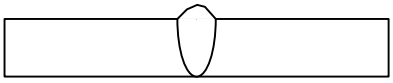
11.2. Welding

The weld ability of the flux-cored wire used is good. All specimens were welded with the same welding current and voltage. The weld beads showed a regular and good aspect.

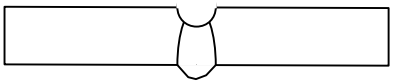
11.3. Economic aspects

All specimens fabricated by Lisnave and sent to TUHH for testing was the type Model-A, V-butt welds.
The Model-B specimen was fabricated for comparison of times consumed purpose.
The results obtained, using the parameters indicated in the Table 5.3 were as follows:

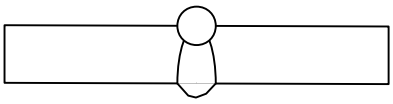
Model-A



Arc time: 3.37 minutes

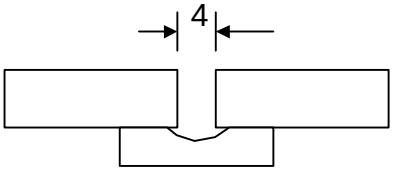


Grinding time: 2.5 minutes



Backing weld
Arc time: 3.18 minutes

Model-B



With ceramic backing
Arc time: 3.80 minutes

V-bevel preparation prepared by grinding is very time consuming.

12. Conclusion

The welding of the specimens has been done without any production problems. From the point of view of expenses, the square butt welds are preferable; a considerable time is involved in the preparation of V-bevel.

In a large scale production MAG welding process automatics with square butt welds and ceramic backing is to be considered.

13. References

1. **TNO** Programme for fatigue tests . Technical Document TD 00.51.01.01 FasdHTS
2. **DILLIMAX –** Technical Information N0.I/1998.
3. **ASME IX –** 1995 Boiler & Pressure Vessel Code

14. APPENDIX I

14.1. Welding Procedure Specification

LISNAVE	WELDING PROCEDURE SPECIFICATION (QW-482) ACCORDING - ASME, Section IX (See QW- 200.1)	**WPS No.:**	**V-002**
		SHEET No.	1 of 2
		DATE :	15-05-01
		SUPPORTING **PQR No.**	

REVISION No.: 0 DATE: 15-05-2001

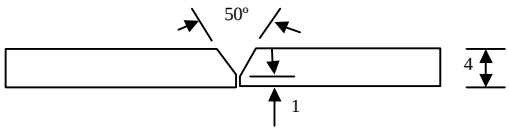
COMPANY NAME: **LISNAVE** BY:

WELDING PROCEDURE(ES): **FCAW** TYPE(S): **MECHANIZED**
AUTOMATIC, MANUAL, MACHINE, OR SEMI-AUTO

DETAILS

JOINTS (QW-402)

JOINT DESIGN: V-BUTT WELD GROOVE 50º
BACKING (YES): ------ (NO): NO
BACKING MATERIAL (Type)
Metal Nonfusing Metal
Nonmetalic Other



BASE METALS (QW-403)

P-No. 1 to P-No. 1

OR SPEC. TYPE AND GRADE: HIGH TENSILE STEEL - HTS690
TO SPEC. TYPE AND GRADE: HIGH TENSILE STEEL - HTS690

OR CH. ANALYSIS AND MECH. PROP.
TO CH. ANALYSIS AND MECH. PROP.

THICKNESS RANGE:

BASE METAL:	PLATE	GROOVE:	1.6 - 8 mm	FILLET:	ALL THICKNESS OF BASE METAL
PIPE DIA. RANGE:	NA	GROOVE:	NA	FILLET:	NA

OTHER: NA

FILLER METALS (QW-404)

SPEC. No. (SFA): A5.29 - 80

AWS No.(CLASS): E 111TG-K3*

F-No.: 6

A-No.: 10

SIZE OF FILLER METALS: Ø 1.2 mm

WELD METAL

THICKNESS RANGE:
GROOVE: 8 mm
FILLET: UNLIMITED

ELECTRODE-FLUX (CLASS): NA

FLUX TRADE NAME: NA

CONSUMABLE INSERT: NA

OTHER: * Fluxofil M42 / M21 (u) "Oerlikon"

POSITIONS (QW-405)

POSITION(S) OF GROOVE: 1 G

WELDING PROGRESSION: N/A

POSITION(S) OF FILLET: N/A

PREHEAT (QW-406)

PREHEAT TEMP.: N/A
INTERPASS TEMP. MAX.: N/A

PREHEAT MAINTENANCE: N/A

POSTWELD HEAT TREATMENT (QW-407)

TEMPERATURE RANGE: N/A

TIME RANGE: N/A

QW-482 (Back)

WPS No:	V-002
SHEET No:	2 of 2
DATE:	15-05-01
REV.:	0

GAS (QW-408)

	PERCENT COMPOSITION		
	GAS(ES)	MIXTURE	FLOW RATE
SHIELDING:	N/A	Ar+20%CO_2	15 l/min
TRAILING.:	N/A	N/A	N/A
BACKING..:	N/A	N/A	N/A

ELECTRICAL CHARACTERISTICS (QW-409)

CURRENT AC OR DC: DC POLARITY: +

AMPS (RANGE): 230 VOLTS(RANGE): 30

TUNGSTEN ELECTR. SIZE AND TYPE: N/A
(PURE TUNGSTEN, 2% THORISTED,ETC)

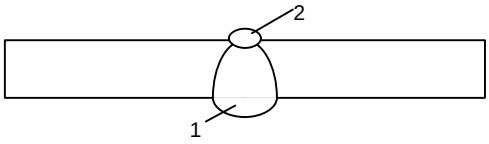
MODE OF METAL TRANSFER FOR **GMAW**: SPRAY
(SPRAY ARC, SHORT CIRCUTTING ARC, ETC,.)

OTHERS: NA

TECHNIQUE (QW-410)

STRING OR WEAVE BEAD:	STRINGER BEAD
ORIFICE OR GAS CUP SIZE:	N/A
Initial and Interpass Cleaning (Brushing, :Grinding, etc.)	GRINDING
METHOD OF BACK GOUGING:	GRINDING
OSCILATION:	N/A
CONTACT TUBE TO WORK DISTANCE:	N/A
MULTIPLE OR SINGLE PASS (PER SIDE):	SINGLE PASS
MULTIPLE OR SINGLE ELECTRODES:	SINGLE
TRAVEL SPEED (RANGE):	40cm/min
PEENING:	N/A
OTHER:	N/A

DETAILS IDENTIFICATION OF PASSES



WELD LAYERS	PROCESS	FILLER METAL CLASS	FILLER METAL DIAM.	CURRENT TYPE POLAR.	CURRENT AMPS RANGE	VOLT RANGE	TRAVEL SPEED RANGE	OTHER (EG., REMARKS, COMENTS, HOT WIRE, ADDITION, TECHNIQUE, TORCH ANGLE, ETC,.)
1 & 2	FCAW	E 111TG-K3	1.2	DC +	230	30	40	ALL VALUES +/- 10%

ORGANISATION: **LISNAVE**	APPROVED BY:
DATE: 2001/02/22 Jose Alexandre SIGN / STAMP	DATE: SIGN / STAMP

15. APPENDIX II

15.1. Steel Plate Certificates

DILLING

ABNAHMEPRÜFZEUGNIS 3.1.B DIN EN 10204 = EN 10204 = DIN 50049
CERTIFICAT DE RECEPTION 3.1.B NF EN 10204
INSPECTION CERTIFICATE 3.1.B BS EN 10204 - ISO 10474 MATERIAL TEST REPORT

53120-30.03.00 | 218735-001

DH | Purchaser WALDRAM, ZALTBOMMEL | 200.0116.0720
Consignee WALDRAM, ZALTBOMMEL

SHOT BLASTED PLATES

Steel grade DILLIMAX 690T-M00
Specification DILLING-DS6:97

--------- B01 CHECKING OF MARKING, SURFACE, SHAPE AND DIMENSIONS ---------
ITEM NO.: 01
RESULT OF MARKING, SURFACE, SHAPE AND DIMENSIONS: NO REMARKS

SURFACE	AS PER EN-10163-A2
THICKNESS	AS PER EN-10029-A:91
LENGTH AND WIDTH	AS PER EN-10029:91
FLATNESS	AS PER EN-10029-TAB:91

--------- Z01-Z99 CONFIRMATIONS ---------
ITEM NO.: 01
IN CASE OF AN INTENDED STRESS-RELIEVING HEAT TREATMENT THE PLATE MANUFACTURER HAS TO BE CONSULTED

QM-System: Certification as per ISO 9001 since 14 March 1990

B. RIEHL/ER

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 31.03.00

DILLI[illegible]

ABNAHMEPRÜFZEUGNIS CERTIFICAT DE RECEPTION INSPECTION CERTIFICATE	3.1.B DIN EN 10204 - EN 10204 - DIN 50049 3.1.B NF EN 10204 3.1.B BS EN 10204 - ISO 10474 MATERIAL TEST REPORT	Date of dispatch: 53728 30.05.00	215779-1-45
DC	Purchaser: WALDRAM, ZALTBOMMEL Final recipient: WALDRAM, ZALTBOMMEL	289.0116.0/JD	Product: SHOT BLASTED PLATE[illegible]

Steel grade DILLIMAX 690T-M00
Specification DILLIMC-036-97

B01-B99 PRODUCT DESCRIPTION

B09 Item No.	B10 Quant	B11 Thick-ness MM	B12 x Width MM	B13 x Length MM	B14 Mass theoret. KG	B04 Delivery condition	B08 Heat No.	B07 Rol.plate/ Test-No.	B16 Customer reference
01	5	4,00	x 2400	x 6000	1383	Q +A	78874	91288	
01	5	4,00	x 2400	x 6000	1383	Q +A	78874	91289 ←	
01	2	4,00	x 2400	x 8000	922	Q +A	78874	91290	
01	5	4,00	x 2400	x 6000	1383	Q +A	78874	91291	
**	11				5071				
***	11				5071				

B06 MARKING

ITEM NO.: 01
STEEL GRADE DILLIMAX690T.M00
HEAT NO. / TRADEMARK / ROLLED PLATE NO./TEST NO. / INSPECTOR'S STAMP

C10-C29 TENSILE TEST

B09 Item No.	B08 Heat No.	B07 Rol.plate/ Test No.	B05 Reference condition	C01 C02/ C03 CDL	C11 Temp. RE	R(HRE) RP02	C12 RM	C13 A% LO=50	C14	C15
01	78874	91289 ←		K Q		712	808	15,1		

C20-C99 CHEMICAL COMPOSITION % - HEAT ANALYSIS

B08 Heat No.	C20	C	SI	MN	P	S	AL	MO	NI	CR	V	NB	B	FO-51
78874	S	0,184	0,268	1,36	0,010	0,0008	0,056	0,506	0,025	0,574	0,088	0,008	0,0018	0,60

C94 CARBON EQUIVALENT FORMULA / ALLOYING RESTRICTIONS

FO-51 = ...

[illegible]

QM-System Certification as per ISO 9001 since 14 March 1990

S. MUELLER

AG der Dillinger Hüttenwerke
Postfach 1580, D-66748 Dillingen/Saar
Inspection department

Date 31.07.00

16. APPENDIX III

16.1. Welding Consumable Data

OERLIKON

Certificado / Certificate

CERTIFICADO Nº:	PEDIDO Nº:	CLIENTE:
2000001670033511	4500004931	SOC. PORTUGUESA DO AR LIQUIDO
FECHA:	ALBARAN Nº:	AV. MARECHAL GOMES COSTA,1145
26/05/01	73253	LISBOA (PORTUGAL) 1800 LISBOA

DESIGNACION: FLUXOFIL 42 1,2x0 — Nº FABRICACION: 1C8109

DESIGNACION NORMALIZADA: AWS A5.29 E110T5-K4

EN COMBINACION CON:

ANALISIS QUIMICO: DEL METAL DEPOSITADO — VALORES: VALOR REAL

C	.065	P	.013	V		Fe		B	
Mn	1.403	Cr	.495	Cu		Ti		N	.0030
Si	.293	Ni	2.247	Al		Co			
S	.007	Mo	.480	Mg		Nb			

PROPIEDADES MECANICAS: DEL METAL DEPOSITADO — VALORES:

LIMITE ELASTICO (N/mm2):	699
RESISTENCIA TRACCION (N/mm2):	782
ALARGAMIENTO (%):	18.0
RESILIENCIA (J):	52 — -51 ºC

TRATAMIENTO TERMICO:

LISNAVE — Visto 01/06/01

OTROS ENSAYOS: — VALORES:

4501006480
3286

NOTA:

C3420/01

Aurelio Arellanda García
Quality Manager

AIR LIQUIDE