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Contract: G3RD – CT 2000 - 00100

Fabrication of box girder for buckling tests

LISNAVE
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DRAFT

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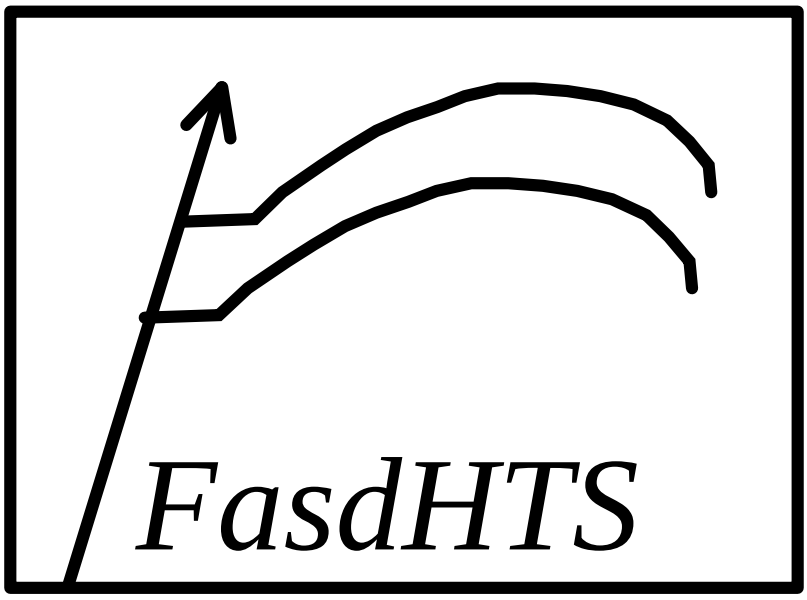

AF – I	**BV**	**CAT**	**CTH**	**DH**	**FSG**	**GL**
GN	**TUHH**	**IST**	**LIS**	**RS**	**TNO**	

G3RD – CT 2000 – 00100 FasdHTS **TD 02.42.01.01**	TESTS ON BOX GIRDERS SUBJECT TO BUCKLING APPLICATION OF HIGH TENSILE STEEL IN SHIPS

Doc. Ref.:	Date : 31 March 2003

TITLE :	**Fabrication of box girders for buckling tests**
Author :	Jose Alexandre
Issued by :	LISNAVE Estaleiros Navais, S.A.

Summary:

This report describes the design and fabrication of the Box girders and the support structure.

Revision	Date	Description	Pages	Checked	Approved
0	31-03-03	Draft		EM	CR

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1 FABRICATION OF BOX GIRDERS FOR BUCKLING TESTS

1.1. OBJECTIVES

The objectives are the fabrication of 3 specimens and 2 supporting structures. The geometry of the specimens according with IST, are the following:

2 BOX GIRDERS

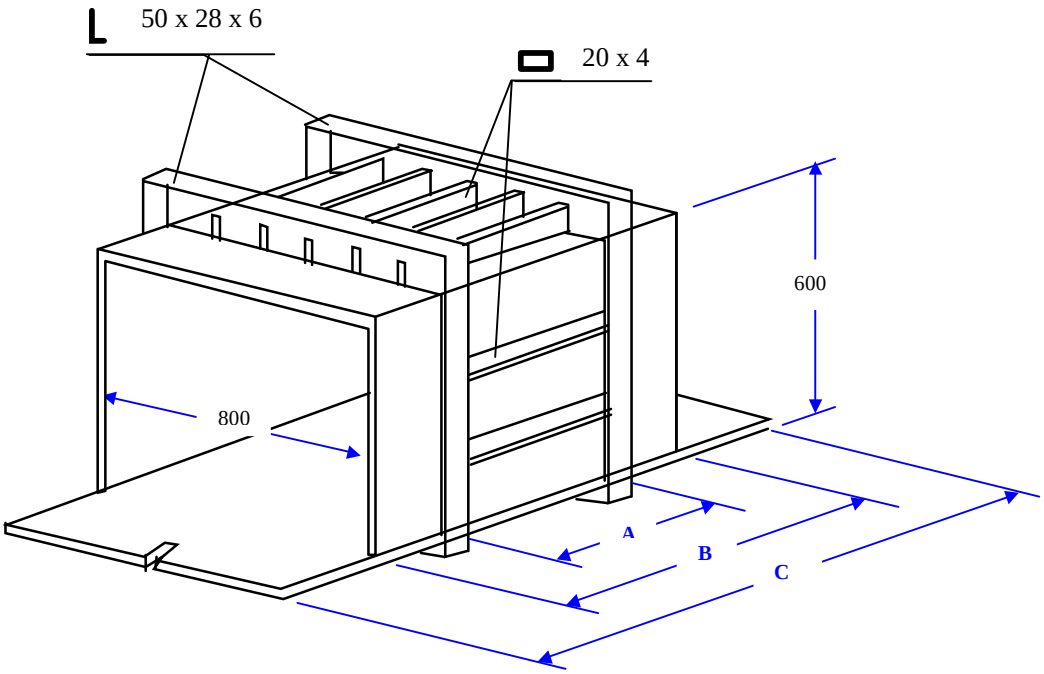


Fig. 2-1 – Box Girder

TABLE: 1 - Model and size specimens

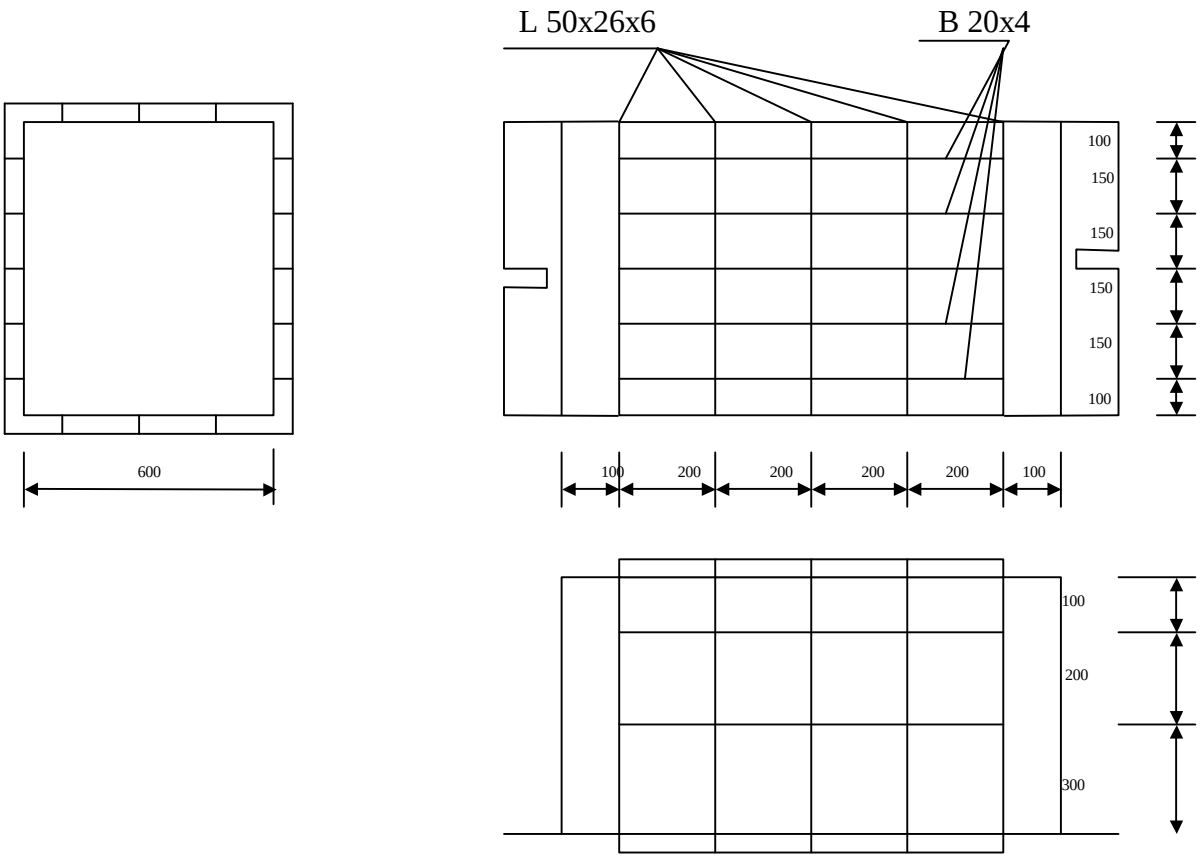
SIZE	SPECIMENS		
	Model H 4 - 150 – 200 x 4	Model H 4 - 150 – 300 x 3	Model H 4 - 150 – 400 x 3
A	800	900	1200
B	1000	1100	1400
C	1150	1250	1550

The box girders have 600 x 800 mm on their cross -section. The length varies accordin g to the number of spans and the spacing between frames, and are 1000, 1100 and 1400 mm. The specimens are designated by three groups: the first is H4 for all of them meaning High Tensile steel of 4 mm thickness; the second indicates the spacing between lo ngitudinal stiffeners; the last is the framing space times the number of spans.

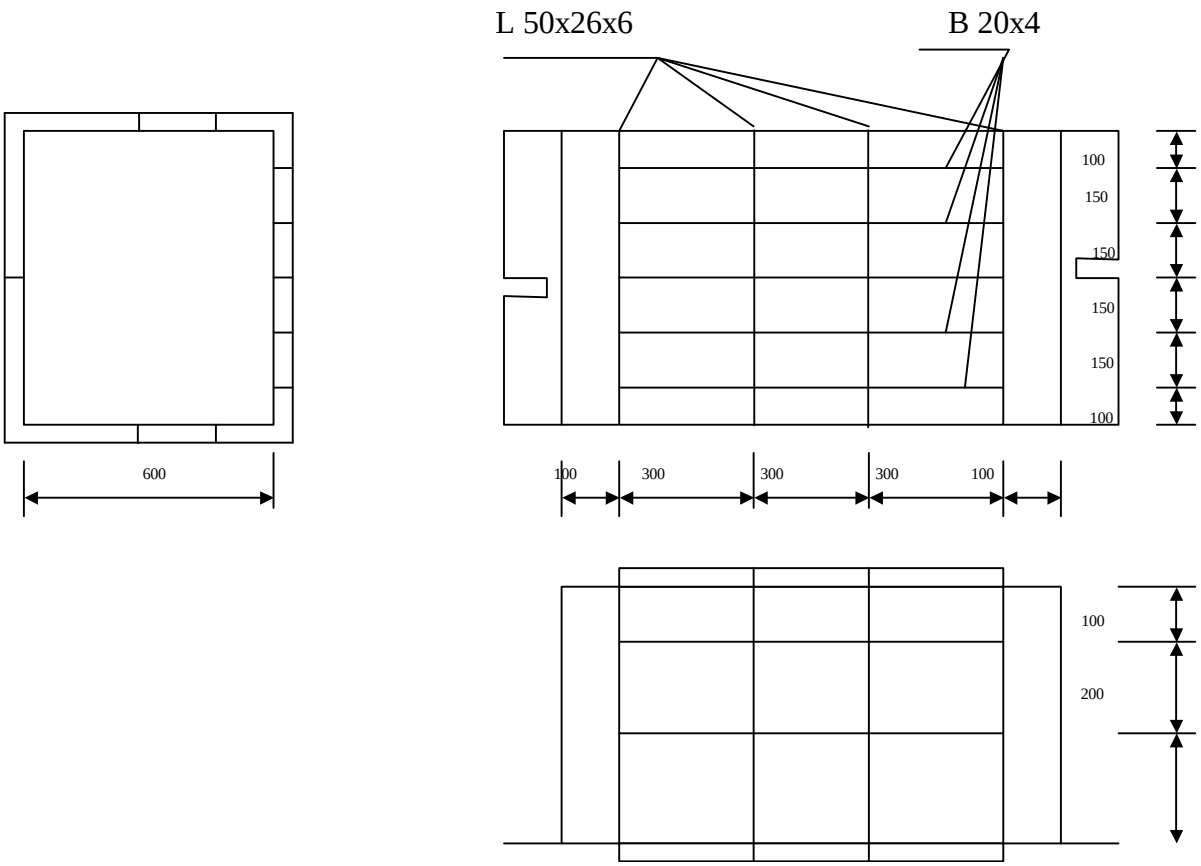
The longitudinal stiffeners are bars of 20 x 4 mm (S690)

The transverse frames are made of normal steel (NS) of 6 mm. They are L profile of 50x28x6.

2.1. Model H4-150-200*4

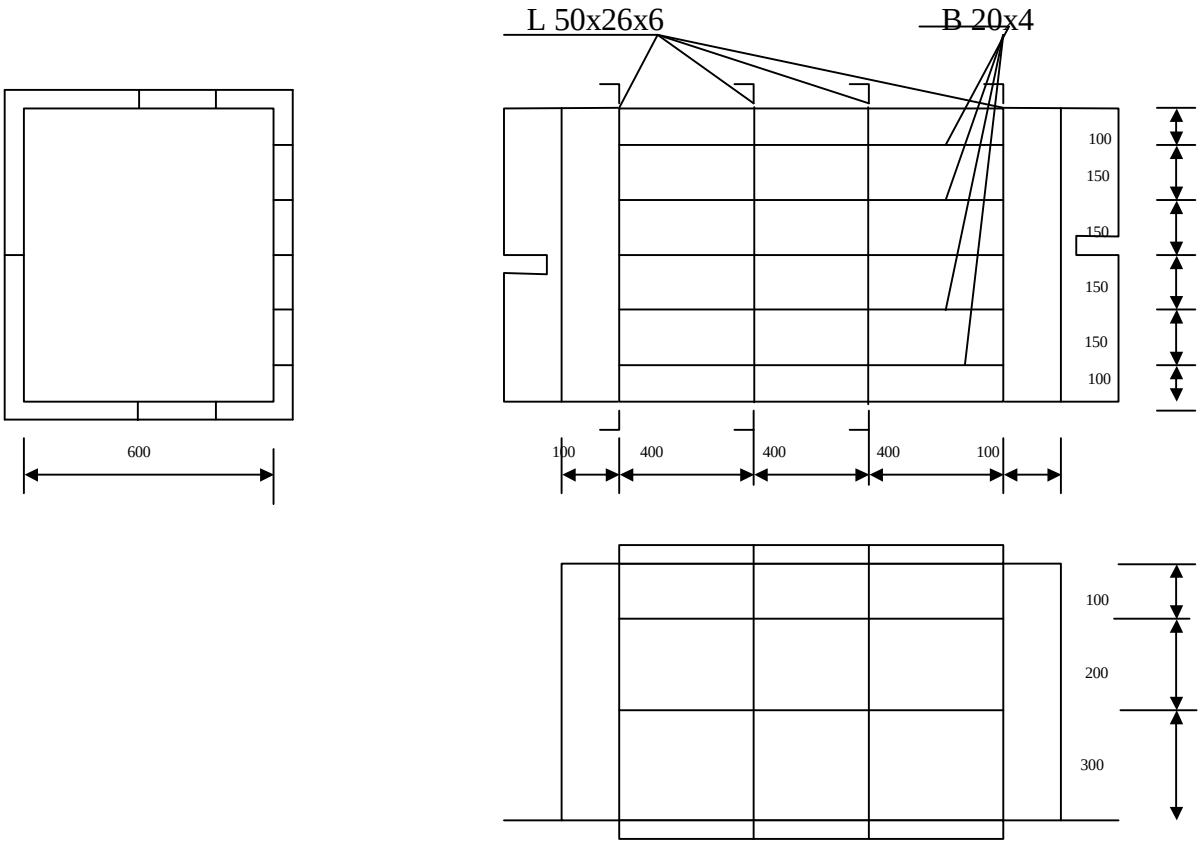


2.2. Model H4-150-300*3



300

2.3. Model H4-150-400*3



Photographic showing the three box girder models

2.4. SUPPORTING STRUCTURE

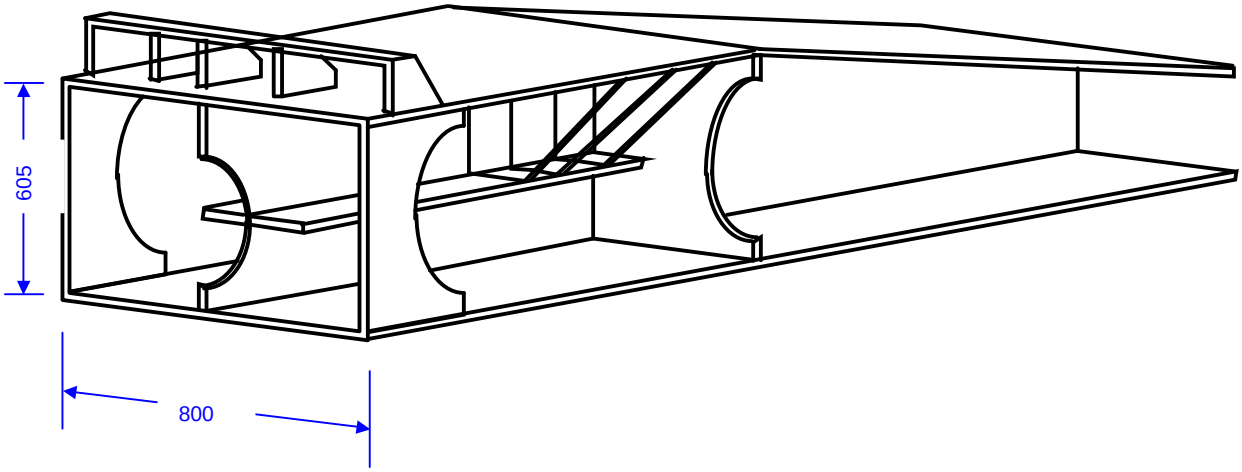


Fig. 2.4 -1 – Supporting Structure

The supporting structures are made of high tensile of 10 mm thicknes s and normal steel.

Supporting structure

3. STEEL

Dillinger Hutten Worke supplied the steel plate (S690) of 10 mm thickness and Waldram -Staal B.V. supplied the steel plate (S690) of 4 mm thickness and Lisnave supplied the normal steel.

A summary of the mechanical properties of the steel is given in Table 3.1 and chemical composition in Table 3.2.

Identificatio mark	Steel			Heat No.	Plate No.
	Quality	Thickness	Grade		
1	DILL 690	10 mm	690 T	52919	20336
2	G.S. 690	4 mm	690 T	103816	
3	G.S. 690	4 mm	690 T	103816	
4	NS	10 mm	A		

Identification mark	Yield Stress N/mm^2	Tensile Strength N/mm^2	Elongation (%)
1,2 and 3	732	808	15
4	235	400/520	22

Table 3.1 – Mechanical properties

Identification mark	Steel		Chemical Composition (%)								
	Qual.	Thick.	C	Mn	Si	P	S	Cr	Ni	Mo	Al
1,2 and 3	690	4/10 mm	0.184	1.36	0.268	0.010	0.008	0.034	0.025	0.006	0.016
4	NS	10 mm	0.21	0.525	0.50	0.035	0.035				

Table 3.2 – Chemical composition

3. FILLER METALS

Chemical composition and mechanical properties:

Designation	Chemical composition								
	C	Mn	Si	S	P	Cr	Ni	Mo	N
H. FLUXOFILL 42	0.068	1.413	0.297	0.007	0.013	0.495	2.247	0.486	0.003

Mechanical properties:

Yield Strength N/mm^2	Tensile Strength N/mm^2	Elongation (%)	Impact Strength (J)
699	782	18	52

4. FITTING AND WELDING SEQUENCE OF THE STRUCTURE

These were the welding sequences and fitting for the fabrication of the box girders.

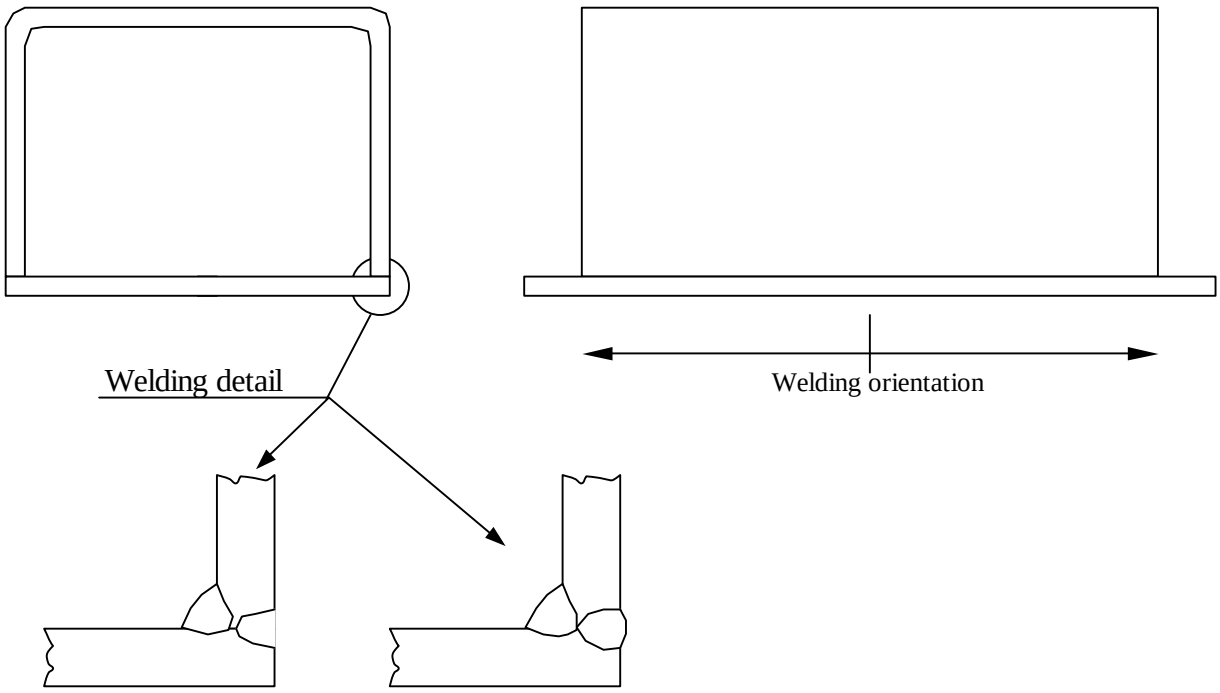


Fig. 5 -1 – Welding details

The welding of the shell was done according detail above, after inside welding, was done a groove by grinding machine, and the we lding.

For longitudinals, the welding sequence was the following:

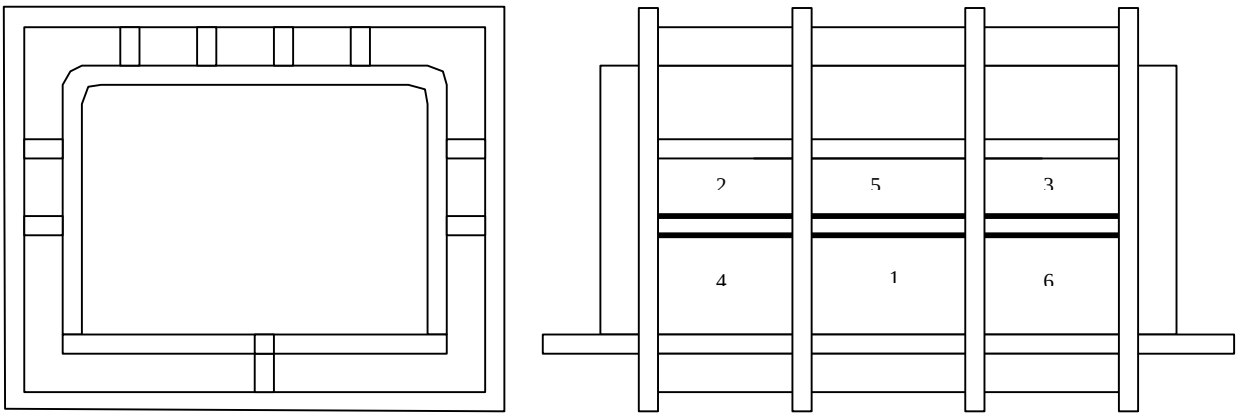


Fig. 5 -2 – Longitudinals welding details

5. FABRICATION OF BOX GIRDERS

The plates were cut using the steel cutting machine for plates and bars of 4 mm thickness (HTS690)

Welding Process: FCAW – Flux cored arc welding.

Welding Parameters:

Weld Layer	Process	Filler Metal		Current		Volt Range
		Class	Dia.	Type Polarity	Amps. Range	
1	Fcaw	AWS A5.29	1.2	+	230-240	23-24

5.1. WELDING

The semi-automatic welding FCAW process was used with constant current and flux -cored wire to weld the specimens and supporting structure. A rutile wire with a diameter of 1.2 mm was used for all the specimens.

Welding box girders

The same welding process and wire was used for tack welding. The welding was done in flat position (PA) for all specimens.

Box girder and supporting structure

5.2. WELDING PROCEDURE SPECIFICATION

As the Yard has no experience in HTS 690 fabrication, the welding procedure specificatio n (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 DIL LIMAX Steels.
Pre-heating temperature of 25ºC min. for thick. Below 5 mm and 125ºC for thick above 5 mm.
Interpass temperature 25 to 225ºC for 10 mm thickness.

Pre-heating used for 10 mm thickness plates was 125ºC, and interpass temperature was 25º to 225 ºC.

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

5.3. NON DESTRUCTIVE TESTING WELDS

The weldings of Box Girders were 100% examined by magnetic particle testing, and no unacceptable indications were found.

6. CONCLUSION

6.1. Preparation of the specimens

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

6.2. Welding

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

The welding of the specimens has been done without any production problems. In a large scale production MAG automatic welding process for fillet welds is to be considered.

7. REFERENCES

1. **TNO** Programme for fatigue tests. Technical Document TD 00.51.01.01 FasdHTS
2. **DILLIMAX** – Technical Information No. I/1998.
3. **ASME IX** – 1995 Boiler & Pressure Vessel Code

8. APPENDIX I - 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

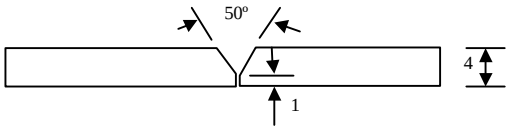
COMPANY NAME: **LISNAVE** BY:

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

JOINTS (QW-402)

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

DETAILS



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)

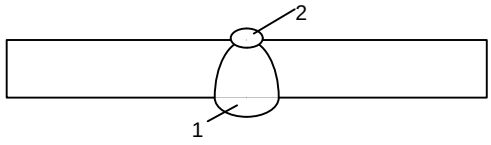
MODE OF METAL TRANSFER FOR **GMAW**: SPRAY
(SPRAY ARC, SHORT CIRCUTTING ARC, ETC.,)

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:
Jose Alexandre	
DATE: 2001/02/22 SIGN / STAMP	DATE: SIGN / STAMP