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STATIC STRAIN MEASUREMENTS ON THE HULL OF AN L.C.H.(U)
JAN 79 S W GEE, I POWLESLAND
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STATIC STRAIN MEASUREMENTS ON THE HULL OF AN L.C.H.

S.W. GEE and I. POWLESLAND

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⑥ STATIC STRAIN MEASUREMENTS ON THE HULL OF AN L.C.H.

⑩ S.W. GEE ~~and~~, I. POWLESLAND

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SUMMARY

Electric resistance strain gauges were fitted to the hull of a heavy landing craft in an attempt to assess the effectiveness of modifications designed to strengthen the hull.

Contrary to all predictions, the values of strain induced by loading the ship were extremely small, while those induced in the hull by various thermal effects were relatively large. No really useable data was obtained from the tests.

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1. INTRODUCTION

Heavy landing craft of the Royal Australian Navy are frequently used for transport on the open sea. Both cracking and buckling of the structure have occurred under these severe conditions.

The Naval Design Office, Canberra, devised a simple modification for strengthening the hull by welding steel bars along the deck and fitting gussets at the front of the bridge structure.

To check the validity of this modification, the Directorate of Naval Ship Design requested that ARL strain gauge a L.C.H. at H.M.A.S. Moreton in Brisbane and measure the changes in strain on the hull while hauling the vessel up onto a slipway for modification. After modification, any damaged gauges were to be replaced and the change in strain while unslipping was to be read. It was hoped that the difference between the two sets of readings would provide a measure of the effectiveness of the modifications to the hull.

2. INSTRUMENTATION

The ship was strain gauged at 12 locations as tabulated in Table 1 and detailed in Figs. 1 to 12.

For rosette gauge positions 1 to 7, Kyowa type KF-2-D3-11 strain gauges were used with a resistance of 120.2 ohms and a gauge factor of 2.09. TML type ZFLA-6 gauges with a resistance of 120 ohms and a gauge factor of 2.12 were used for linear gauge positions 8 to 12.

One active and one temperature compensating dummy gauge was used at each location and each gauge was also self temperature compensated for use on steel.

Standard surface preparation and cleaning techniques were employed, the gauges being attached with Micro Measurements M. Bond 200 cyanoacrylate adhesive.

Waterproofing was carried out by coating the gauge positions with Micro Measurements M. Coat D waterproofing followed by a generous coating of Selleys PR120IQ polysulphide rubber, electrical potting compound.

Light metal covers were placed over installations on the deck as protection from mechanical damage.

Wiring from the gauges to an instrumentation hut located on the well deck of the L.C.H. was carried out using 5 core shielded cables.

Readings from the strain gauges were taken on manually operated static strain indicators, connected to the gauge installations via twelve channel switch boxes, located in the instrumentation hut.

3. TEST PROCEDURE AND RESULTS

Zero readings were taken on all strain gauges with the ship afloat, immediately before slipping and at regular intervals until it was fully up the slipway. Indicated strains were very much smaller than we had been led to expect, varying from one micro-strain in gauge 4C to 68 micro-strain in gauge 12, instead of the 300 or greater micro-strain which had been predicted.

The stiffening bars were then welded to the ship, damaged gauges were replaced where necessary and a further set of readings taken during unslipping of the ship.

Values of strain, measured during slipping and unslipping of the vessel are shown in Table 2, together with typical changes in strain due to purely thermal effects on the hull, lying at rest in the water, over a similar time span, with no load applied.

Intermediate results taken with the hull partially out of the water have not been tabulated in this report.

Unfortunately the thermal stress effects were so large that they caused grave doubts on the validity of strains measured during the two hour period required to slip or unslip the ship. Small differences between the two sets of results were quite meaningless and it was not possible to give any real estimation of the effectiveness of the modification to the ship from these results.

Attempts were then made to secure useful data by ballasting the ship. The fuel tanks were filled and water was pumped into and out of various ballast tanks in the hull.

Again thermal effects caused by differences in temperature between the fuel and water pumped into the hull and the structure, plus the sun heating one side of the ship, then the deck and the other side during the day, gave errors which defeated the purpose of the exercise.

Typical values of indicated strain, obtained by ballasting the ship from a maximum sagging to a maximum hogging condition are shown in Table 3, together with typical thermal effects, over relatively short periods, with no change in loading on the ship. Ballasting between the two above conditions required some seventeen hours.

Single strain gauges of the type used, indicate a zero shift of approximately 1.8 micro-strain per degree celsius when attached to steel. When used in conjunction with temperature compensating dummy gauges, attached to unstrained steel plates, this figure drops to less than 0.3 micro-strain per degree celsius.

The zero shift in the gauge bridges, would therefore be a maximum of approximately 5 micro-strain, with temperature change, while those gauges on the sides of the hull below the water line, should have been close to zero. It appears that the indicated strains were pure thermal strains, caused by the deck, superstructure and bulkheads expanding or contracting in the sun while the bottom of the ship remained at a stable temperature.

The magnitude of the thermal effects clearly swamped any data obtained from ballasting the ship. Numerous runs were taken in an endeavour to separate the thermal response of the ship from the mechanical strain applied, but no clear picture emerged. Thermal strains changed in a completely unpredictable manner.

Testing was terminated when the ship sailed.

4. CONCLUSIONS AND RECOMMENDATIONS

Because of the extremely small strains induced by loading the hull and the large strains induced by thermal effects on the ship, no really useful data could be obtained from the tests.

To minimise these thermal problems in any future static tests, a rapid method of loading the hull to a condition producing more realistic strains should be used. Testing should also be carried out in the early hours of the morning when the hull should be in a more thermally stable condition.

Dynamic test runs on the open sea would certainly produce much larger strains on the hull, but multi-channel dynamic instrumentation would have to be developed to record the data accurately. A number of accelerometers would also be required to help correlate the strain data and permit comparison between tuns taken before and after any future modifications. The project would thus become a major research effort which would have to be justified because of the high costs involved.

TABLE 1

POSITION NO.	GAUGE TYPE	LOCATION OF STRAIN GAUGES
1	Rosette	Upper deck Port side; 152 mm forward of WTB 22 and 330 mm from inboard edge of deck.
2	Rosette	Upper deck starboard side; 1257 mm aft of WTB 22 and 330 mm from inboard edge of deck.
3	Rosette	Tank deck Port side; 152 mm forward of WTB 22 and 908 mm from side of ship.
4	Rosette	Starboard portable plate hatch on outboard side wall 1854 mm aft of WTB 22 and 305 mm above deck.
5	Rosette	Engine room; panel of WTB 22, 102 mm to Port of ship centre-line and 572 mm above level of tank deck.
6	Rosette	Engine room; starboard side plate, 1181 mm aft of WTB 22 and 102 mm above chine weld.
7	Rosette	Engine room; starboard side plate, 108 mm forward of 10th vertical stiffener back from WTB 22 and 2432 mm below level of upper deck.
8	Linear	Engine room; starboard side, on the edge of the eighth vertical stiffener back from WTB 22 and 133 mm below top corner gusset.
9	Linear	Engine room; port side, on the edge of the tenth vertical stiffener back from WTB 22 and 368 mm above chine weld.
10	Linear	Engine room; starboard portable plate hatch frame on forward stiffener 127 mm from WTB 22 and 279 mm from side of hatch.
11	Linear	Engine room; starboard portable plate hatch frame on side stiffener 445 mm aft of WTB 22.
12	Linear	Upper deck; starboard side of 5563 mm forward of WTB 22 and 451 mm from side of ship.

<u>TABLE 2</u>

STRAIN GAUGE POSITION NO.	CHANGES IN STRAIN (MICRO STRAIN)		
	SHIP FLOATING TO FULLY UP SLIPWAY UNMODIFIED	SHIP FULLY UP SLIPWAY TO FLOATING MODIFIED	SHIP FLOATING THERMAL EFFECTS OVER 2 HOUR PERIOD. NO LOAD APPLIED.
Rosette			
1a	53	-14	-18
b	20	-8	-13
c	18	20	-26
Rosette			
2a	73	-72	-15
b	51	-22	2
c	-1	91	8
Rosette			
3a	33	-46	-11
b	-28	-7	-28
c	-12	37	12
Rosette			
4a	6	-5	-10
b	-19	21	16
c	4	-1	-12
Rosette			
5a	8	-7	-25
b	-32	-1	-10
c	-28	-16	9
Rosette			
6a	-28	85	3
b	47	-14	-1
c	24	-40	-5
Rosette			
7a	-35	67	0
b	-44	49	0
c	-4	-35	-3
Linear 8	0	-32	1
Linear 9	21	-75	32
Linear 10	7	4	2
Linear 11	20	-39	-35
Linear 12	74	-54	-1

TABLE 3

	CHANGES IN STRAIN MICRO STRAIN		
STRAIN GAUGE POSITION NO.	LOADING FROM MAXIMUM SAGGING TO MAXIMUM HOGGING	SHIP WARMING UP NO LOADING APPLIED 5.15 AM TO 7.15 AM.	SHIP WARMING UP NO LOADING APPLIED 8.00 AM TO 1.15 PM.
Rosette 1a	104	56	-96
b	41	8	82
c	-4	17	166
Rosette 2a	121	112	-300
b	43	71	-227
c	2	18	59
Rosette 3a	76	43	-103
b	74	-37	41
c	-58	-3	71
Rosette 4a	7	26	-10
b	-47	-30	-53
c	-31	7	38
Rosette 5a	-35	-18	206
b	7	10	24
c	25	14	-122
Rosette 6a	-31	39	-21
b	82	28	-5
c	5	-6	43
Rosette 7a	30	37	-27
b	34	25	5
c	-36	10	29
Linear 8	-108	17	45
Linear 9	8	-3	-52
Linear 10	-74	-38	42
Linear 11	130	32	-2
Linear 12	83	78	18

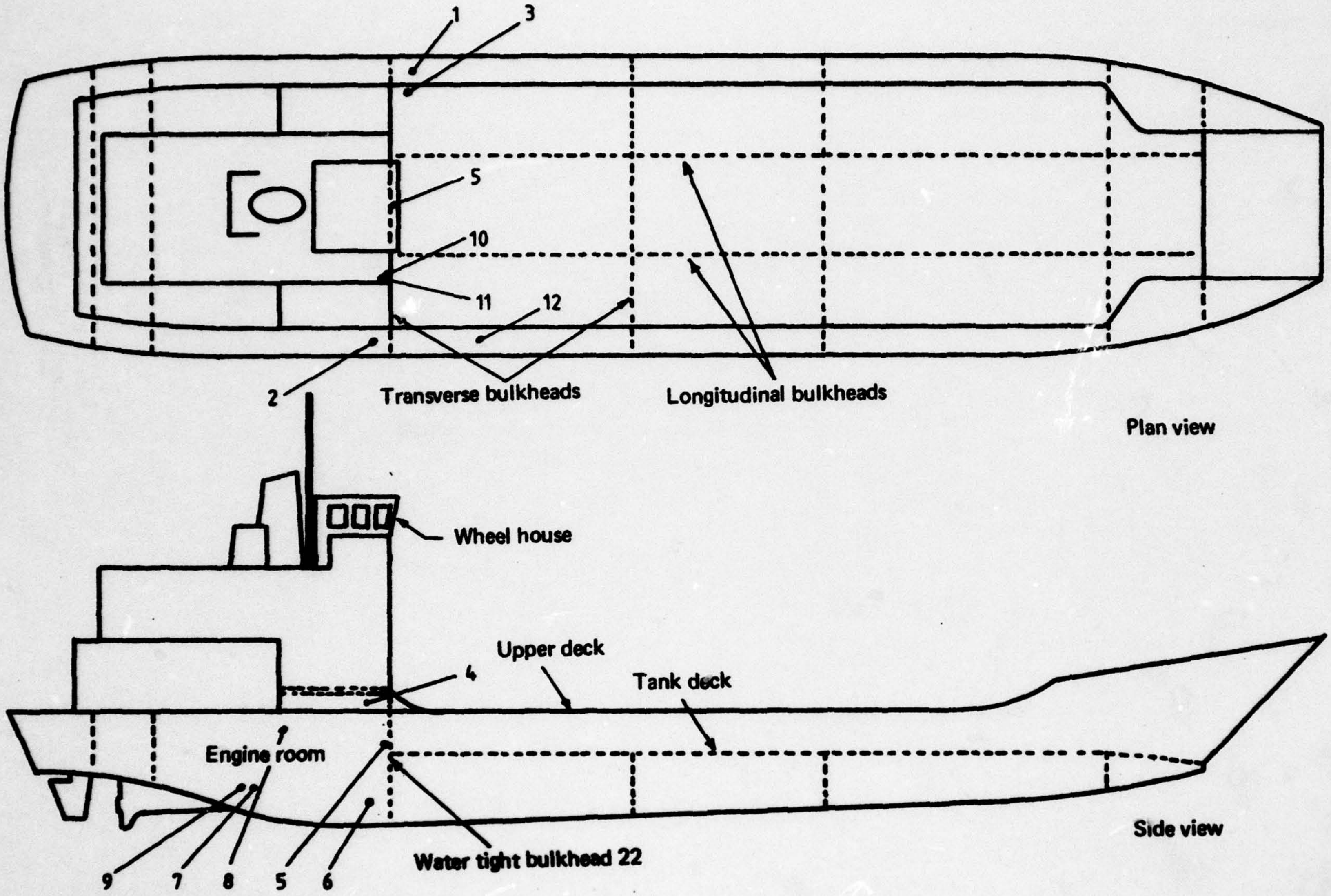

FIG. 1. GENERAL LAYOUT OF SHIP SHOWING GAUGE LOCATIONS.

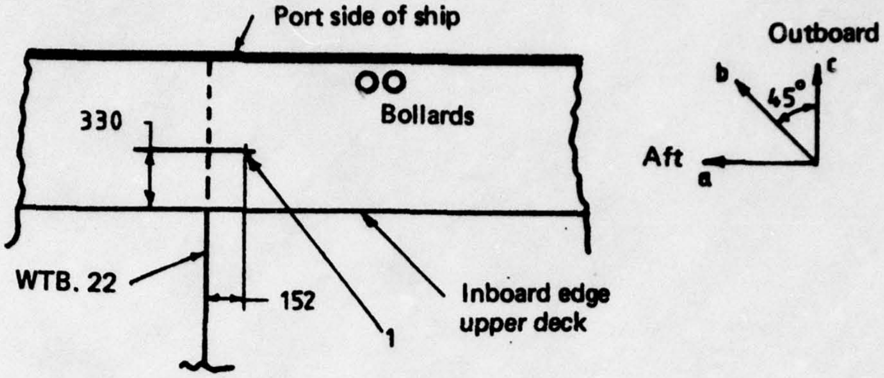

FIG. 2. ROSETTE GAUGE No. 1 ON UPPER DECK.

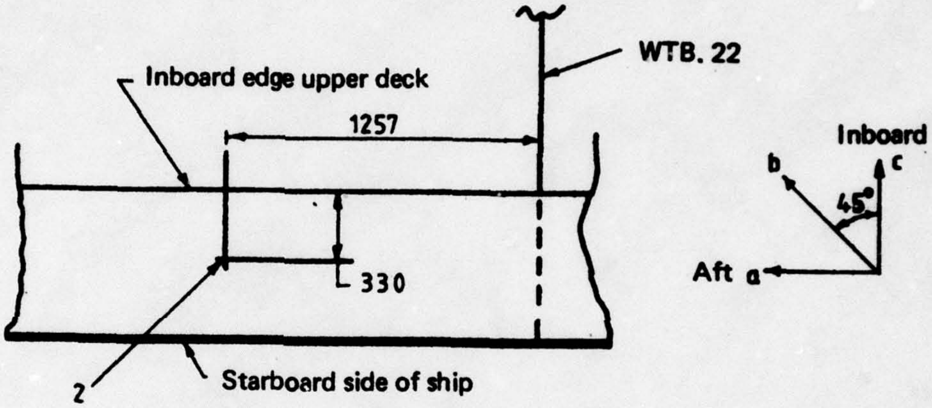

FIG. 3. ROSETTE GAUGE No. 2 ON UPPER DECK

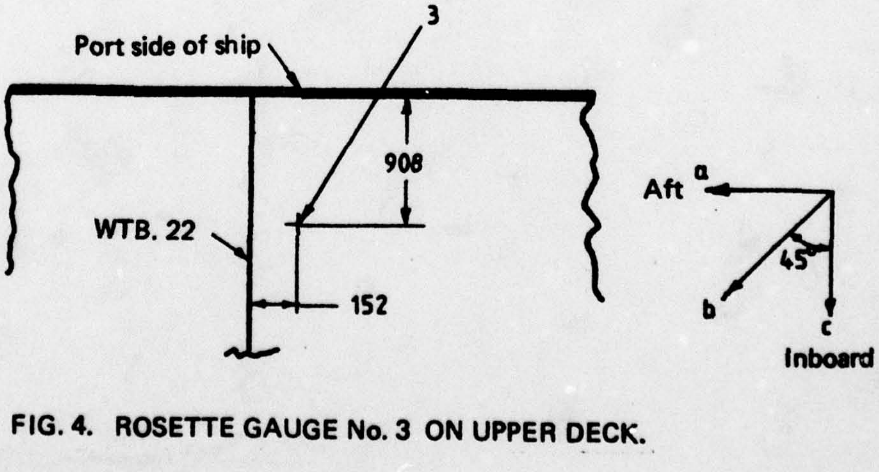

FIG. 4. ROSETTE GAUGE No. 3 ON UPPER DECK.

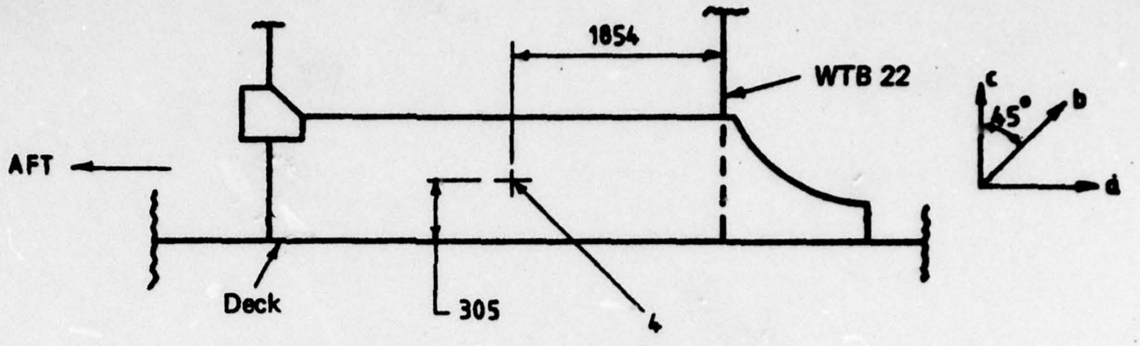

FIG. 5. ROSETTE GAUGE No. 4 ON SIDE WALL OF PORTABLE PLATE HATCH

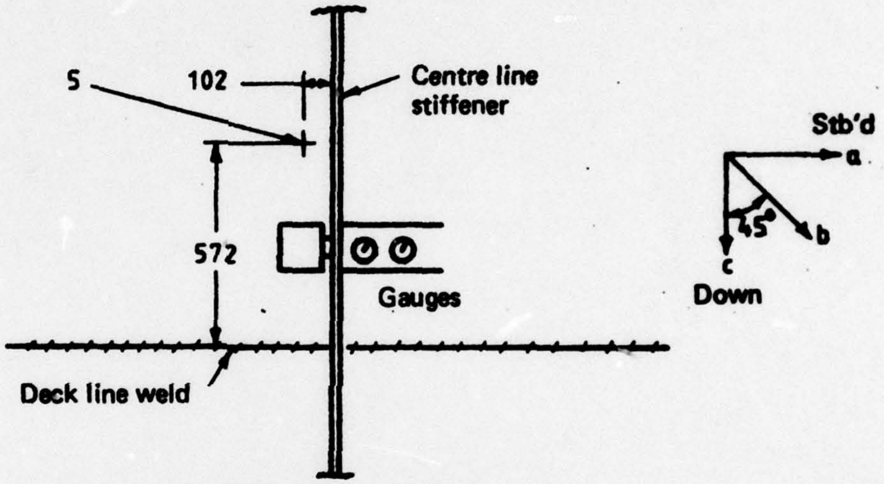

FIG. 6. ROSETTE GAUGE No. 5. ON WTB. 22.

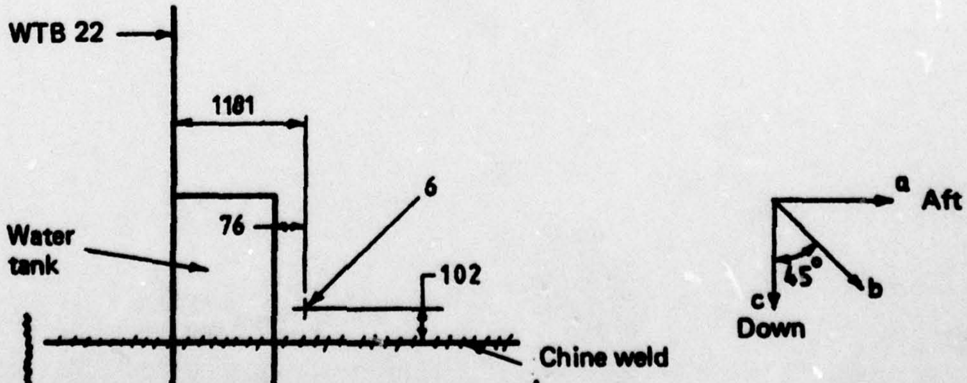

FIG. 7. ROSETTE GAUGE No. 6. ON STARBOARD SIDE OF HULL.

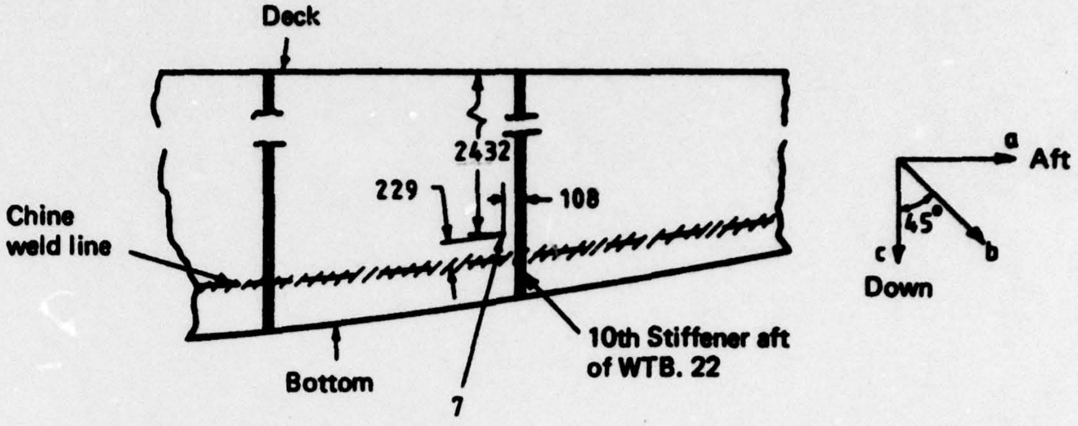

FIG. 8. ROSETTE GAUGE No. 7 ON STARBOARD SIDE OF HULL

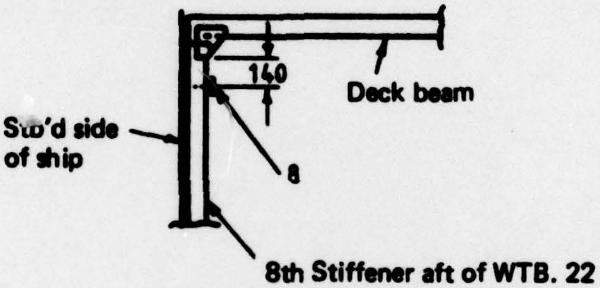

FIG. 9. LINEAR GAUGE No. 8 ON EDGE OF STIFFENER No. 8 AFT OF WTB 22

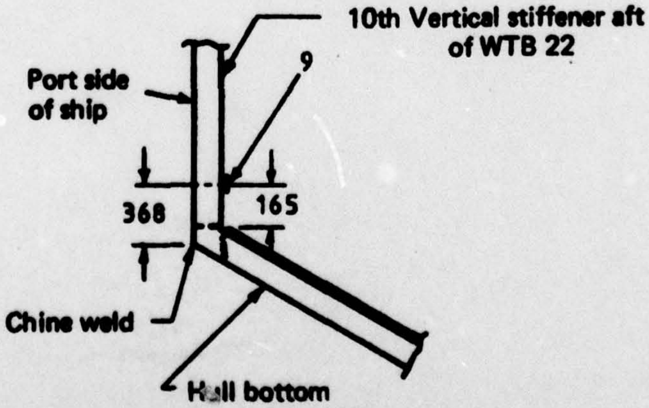

FIG. 10. LINEAR GAUGE No. 9 ON EDGE OF STIFFENER No. 10 AFT OF WTB. 22

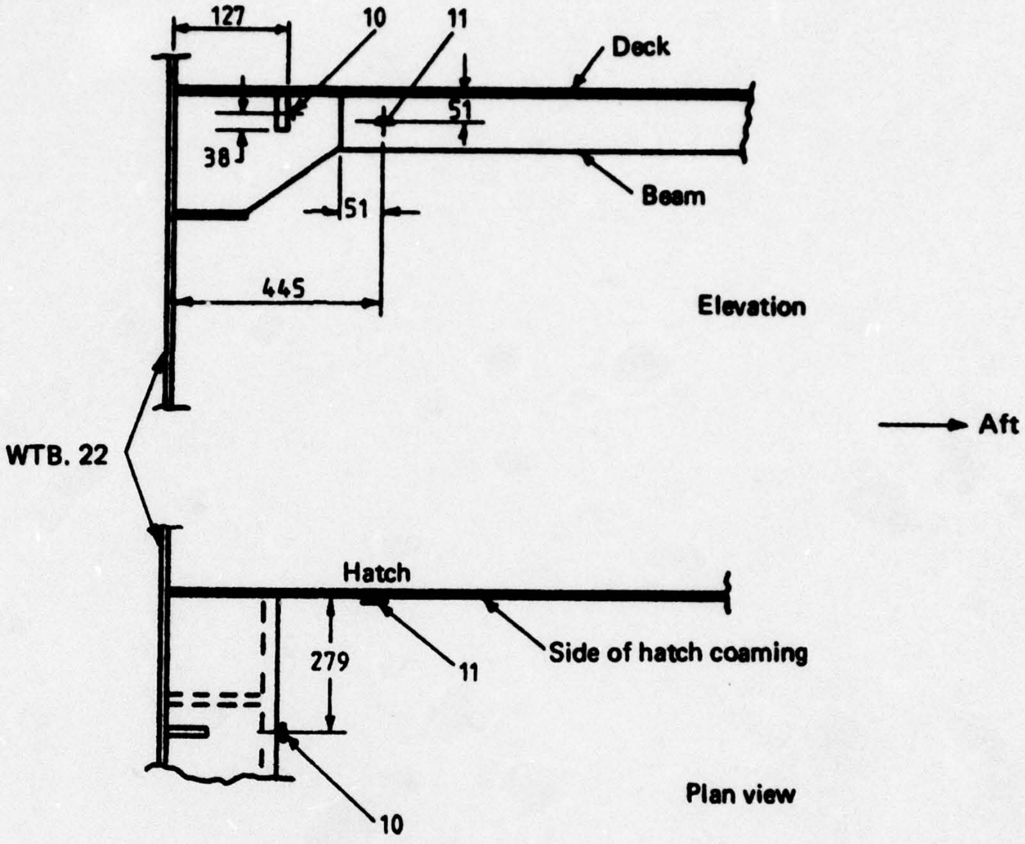

FIG. 11. LINEAR GAUGES No 10 & No 11 ON STARBOARD HATCH COAMING.

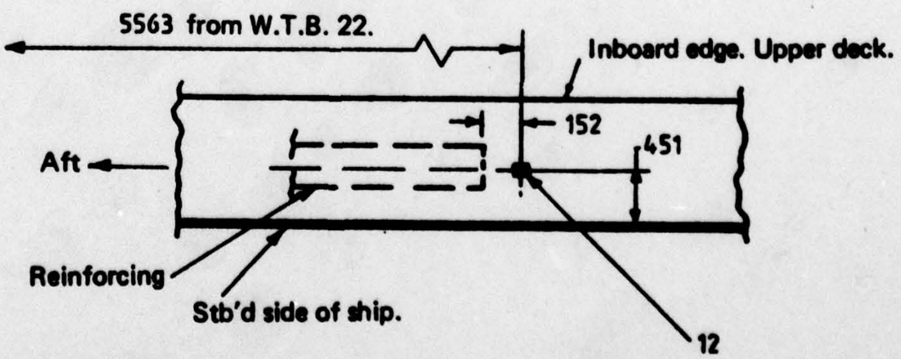

FIG. 12. LINEAR GAUGE No. 12 ON STARBOARD UPPER DECK

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16. ABSTRACT:

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Contrary to all predictions, the values of strain induced by loading the ship were extremely small, while those induced in the hull by various thermal effects were relatively large. No really useable data was obtained from the tests.

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