

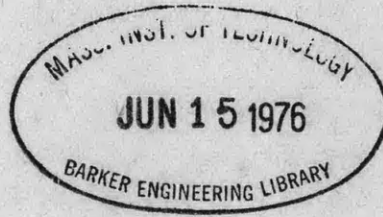
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REPORT OF ROLLING EXPERIMENTS ON MODEL NO. 2375,
REPRESENTING U. S. CRANE SHIP NO. 1



U.S. EXPERIMENTAL MODEL BASIN
Navy Yard, Washington, D.C.

March 1923

Report 69

REPORT OF ROLLING EXPERIMENTS ON MODEL NO. 2375,
REPRESENTING U.S. CRANE SHIP NO. 1

1. The object of this test was to investigate the action of the model in waves and to determine the effect of bilge keels and of a change in the radius of gyration, the displacement, height of the center of gravity and radius of gyration of the model being made to correspond with those of the ship.

2. The data furnished to the Model Basin for the Crane Ship, comprised two conditions, the first of which, with the corresponding model dimensions, was as follows:

Condition No. 1

	Ship	Model
Displacement	11,400 tons	4,003 pounds
Height of C.G.	21.7 feet	1.179 feet
Radius of gyration	25 feet	1.358 feet
Linear Ratio, Ship to Model = 18.4		

The model was ballasted accordingly.

3. To obtain the declining angle curve and the natural rolling period for the condition above, the model was rolled in still water. A typical record, made by the gyroscopic roll recorder, is shown on Sheet II; and the resulting declining angle curve on Sheet I.

4. The wave maker was next put in operation and the model rolled in waves produced by settings of increasing eccentricity until it began to ship a considerable amount of water.

This occurred when an eccentricity of 2 inches was reached, producing waves of 4 inches to 5 inches in height and about ten feet in length. Spray shields were fastened to the weather side of the model along the deck to prevent water coming aboard, and a setting of 2 inches eccentricity of the wave maker was adopted for the test. A record made during this experiment will be found on Sheet V.

5. To obtain the effect of bilge keels on the behavior of the model when in this condition, keels were attached as indicated on Sheet I. The model was again rolled in still water, and records and declining angle curves obtained as shown on Sheets II and I, respectively. Rolled in waves, records were produced as illustrated on Sheet V.

6. The data for the ship and model in the second condition was as follows:

Condition No. 2

	Ship	Model
Displacement	13,100 tons	4,600 pounds
Height of C.G.	23.4 feet	1.272 feet
Radius of gyration	25 feet	1.358 feet
Linear Ratio, Ship to Model = 18.4		

After the model had been ballasted to this condition, it was rolled in still water and in waves, with and without bilge keels. Records made during each of these experiments are shown on Sheets III and VI, and the declining angle curves on Sheet I.

7. To determine the effect of a change in the radius of gyration, it was decided to roll the model in two or more conditions, in one of which the ballast was to be "winged out" as far as possible and in the other to be centralized. The data for the third condition was as follows, the ballast being "winged out" as far as possible and the bilge keels left off.

Condition No. 3

	Ship	Model
Displacement	13,100 tons	4,600 pounds
Height of C.G.	23.4 feet	1.272 feet
Radius of gyration	27.6 feet	1.50 feet

8. It was considered that the natural rolling period might be obtained more accurately from a record of the model rolling regularly under the action of a weight having harmonic motion athwartships than from a record for declining angle. A machine actuating a weight in the desired manner was therefore installed. The records made under these conditions are shown on Sheet IV. While still in condition No. 3, the model was again rolled in waves, a record being shown on Sheet VII.

9. The model was then put in the fourth condition by moving the ballast as near the center line as possible.

Condition No. 4

	Ship	Model
Displacement	13,100 tons	4,600 pounds
Height of C.G.	23.4 feet	1.272 feet
Radius of gyration	22.1 feet	1.20 feet

Records made in still water under induced rolling and also when rolling in waves are shown on Sheets IV and VII, respectively.

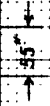
10. To draw a conclusion as to the effect of the bilge keels, a comparison was made between rolling records of the model, with and without bilge keels. On Sheet I, the number of swings necessary to reduce the angle of keel from $6\frac{1}{2}$ degrees to 1 degree, when the model was in the first condition was reduced from 9.2 to 7.3 by the addition of the bilge keels; a reduction of 21 per cent. In the second condition the reduction was from 13.1 to 8.4 or 36 per cent. When in the first condition and rolling in waves, the bilge keels reduced the maximum angle of roll from 24.9 degrees to 18.1 degrees, a reduction of 27 per cent (see Sheet V). In the second condition, rolling in waves, the bilge keels reduced the maximum angle of roll from 20.5 degrees to 9.8 degrees, a reduction of 52 per cent (see Sheet VI). The effect was thus greater when the period of roll was increased, but still appears comparatively small when the large size of the keels is considered.

11. The effect of a change in the radius of gyration is shown by a comparison of the records on Sheets IV and VII. Here a decrease in radius from 1.50 feet to 1.20 feet, or 20 per cent, reduced the period of roll in still water from 1.79 seconds to 1.47 seconds, or 18 per cent. The reduction in period when rolling in waves was from 1.91 seconds to 1.67 seconds, or $12\frac{1}{2}$ per cent. This reduction of period in waves was very approximate, as it depended upon obtaining the period from synchronous rolling and it would appear from a comparison of the other records that the period should have been smaller when the model was in condition No. 4, making a reduction more nearly like that obtained from the records taken in still water.

The change of radius, however, within the experimental limits, seems to have very little effect on the maximum angle of roll.

LWL 13,100 TONS DISP
 LWL 11,720 "

BILGE KEELS 166' LONG AND
 4'-7" DEEP



DECLINING ANGLE CURVES
 FOR
 MODEL NO R375
 REPRESENTING
 U.S. CRANE SHIP NO 1

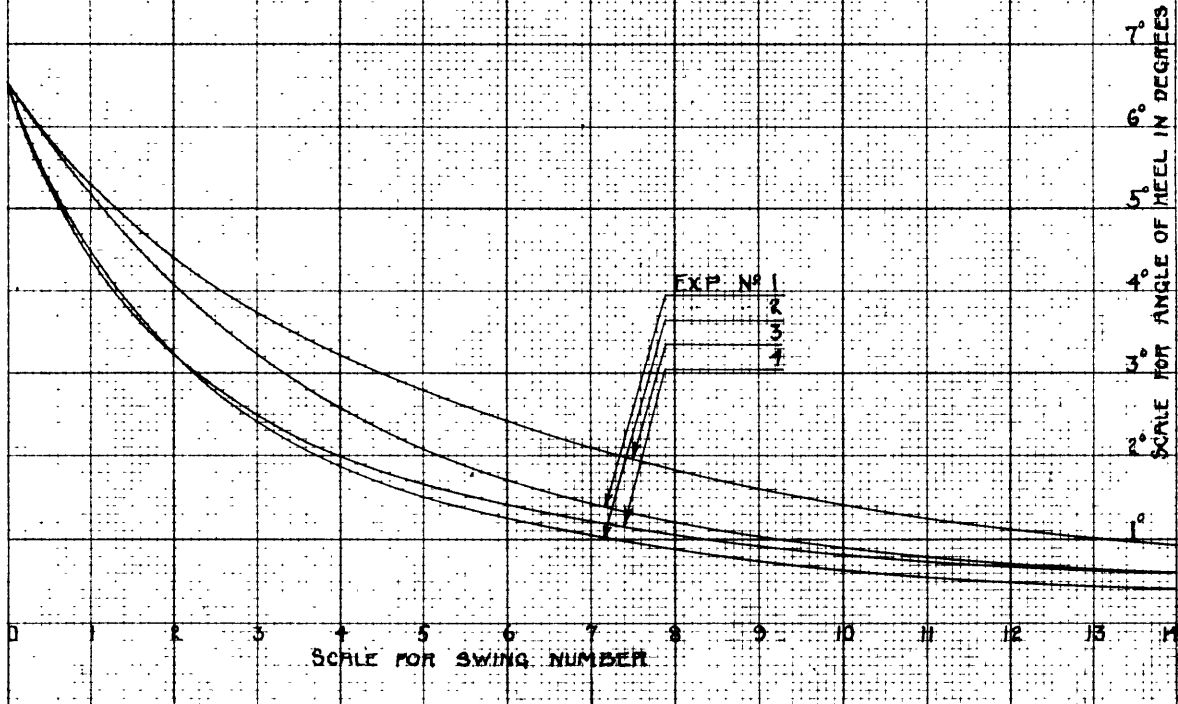
EXP NO	DISPLACEMENT		G. M.		CYCLIC PERIOD		BILGE KEELS	RADIUS OF GYRATION	
	MODEL	SHIP	MODEL	SHIP	MODEL	SHIP		MODEL	SHIP
1	4003 LBS	11,400 TONS	1.354	21.9	1.51 SEC	6.48 SEC	OFF	1.358	25'
2	"	"	"	"	1.63	7.00	ON	"	"
3	4600	13,100	1.092	20.1	1.65	7.08	OFF	"	"
4	"	"	"	"	1.76	7.55	ON	"	"

LINEAR RATIO, SHIP TO MODEL, = 12.4

EXPERIMENTAL MODEL BASIN

NAVY YARD, WASHINGTON D. C.

FEB. 1923



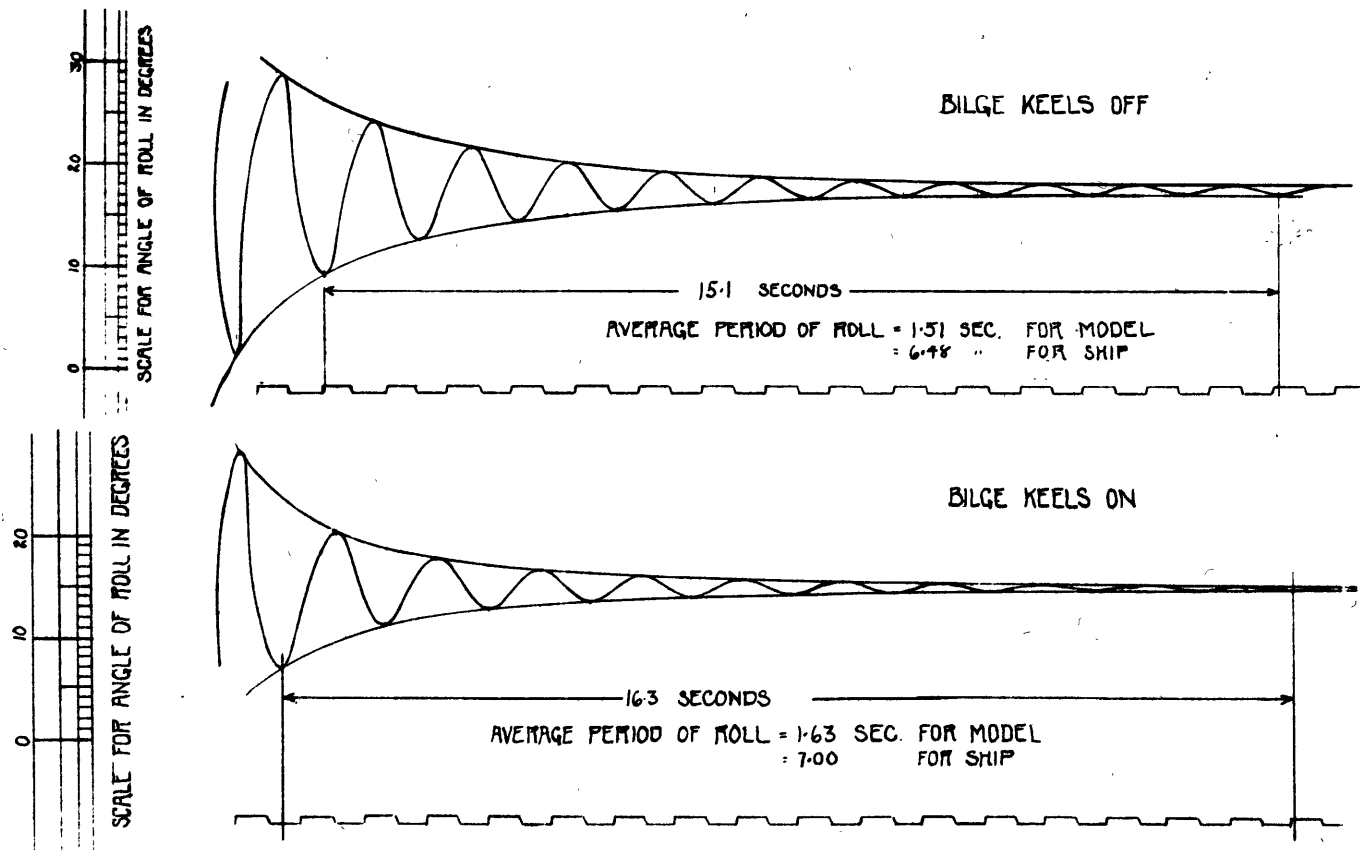
GYROSCOPIC ROLLING RECORDS

FOR
DECLINING ANGLE CURVES
FROM TEST OF
MODEL N° 2375
REPRESENTING
U.S. CRANE SHIP N° 1

	MODEL	SHIP
RADIUS OF GYRATION	1.356	25'
G. M.	1.354	24.9
DISPLACEMENT	4003 LBS.	11,400 TONS
LINEAR RATIO SHIP TO MODEL	18.4	

EXPERIMENTAL MODEL BASIN
NAVY YARD WASHINGTON DC

FEB. 1923.



SHEET II

GYROSCOPIC ROLLING RECORDS

FOR
DECLINING ANGLE CURVES

FROM TEST OF
MODEL NO 2375

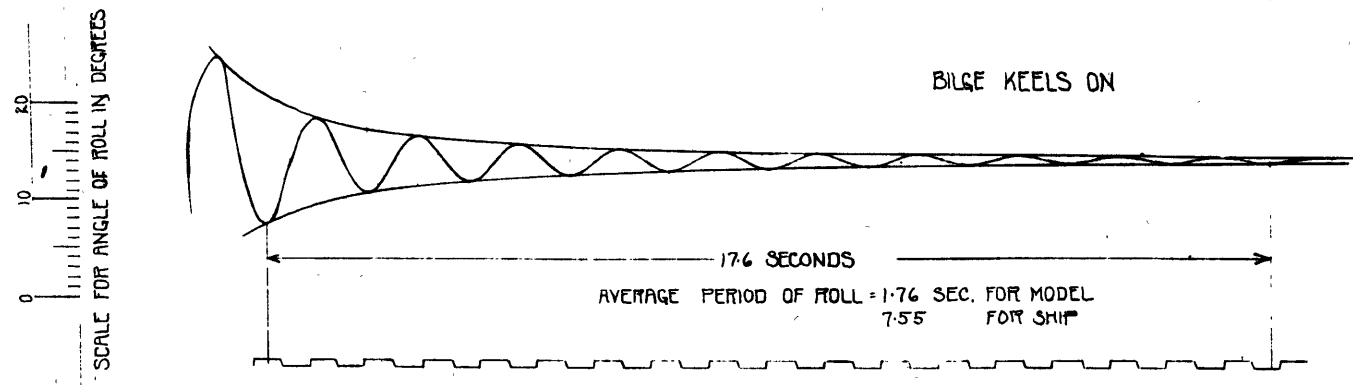
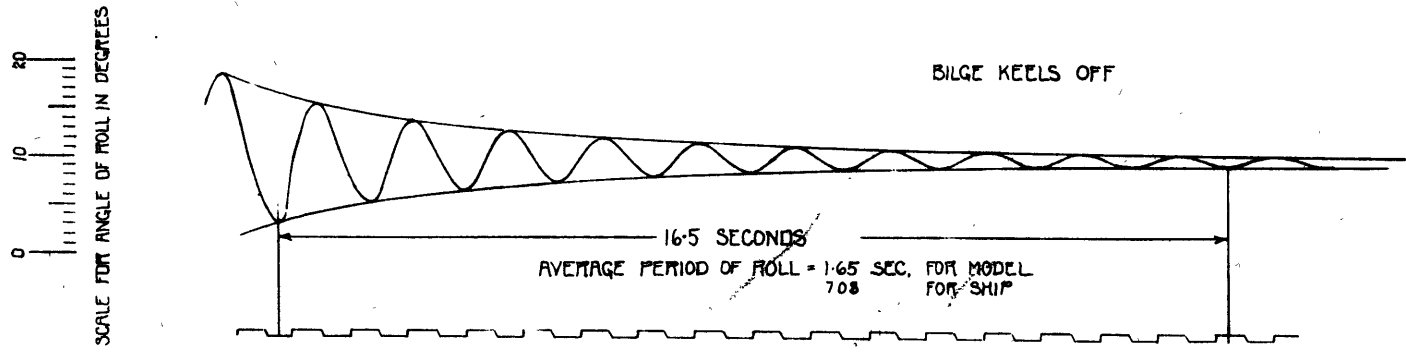
REPRESENTING
U.S. CRANE SHIP NO 1

RADIUS OF GYRATION	MODEL 1'358	SHIP 25'
G. M.	1'092	20'
DISPLACEMENT	4600 LBS	13,100 TONS
LINEAR RATIO SHIP TO MODEL = 18.4		

EXPERIMENTAL MODEL BASIN

NAVY YARD WASHINGTON D.C.

FEB. 1923



GYROSCOPIC ROLLING RECORDS
 TO DETERMINE
 NATURAL ROLLING PERIOD OF MODEL N° 2375

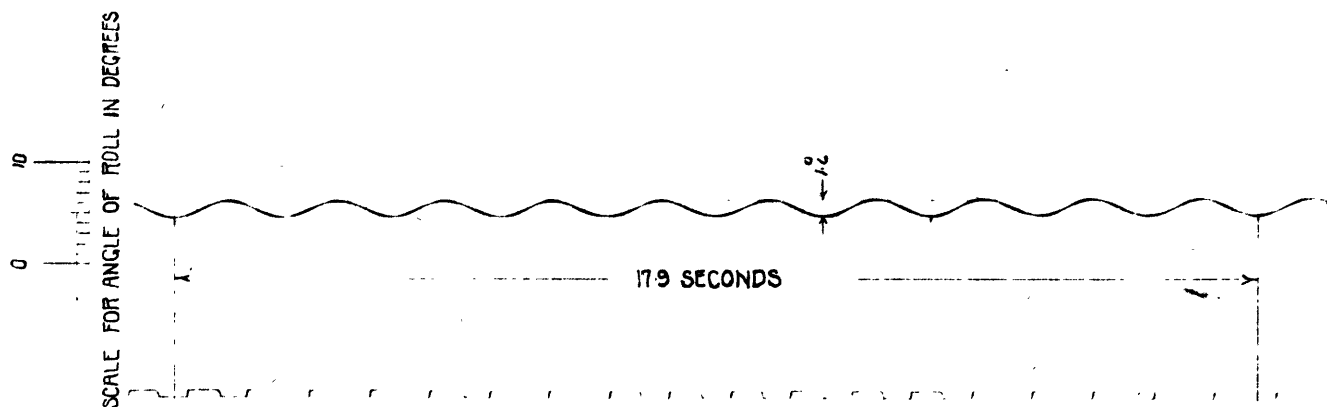
REPRESENTING
 U.S. CRANE SHIP N°1

BILGE KEELS OFF
 ROLLING INDUCED BY WEIGHT SHIFTING MACHINE

	MODEL	SHIP
G. M.	1.092	20.1
DISPLACEMENT	4,600 LBS	13,100 TONS
LINEAR RATIO SHIP TO MODEL	= 18.4	

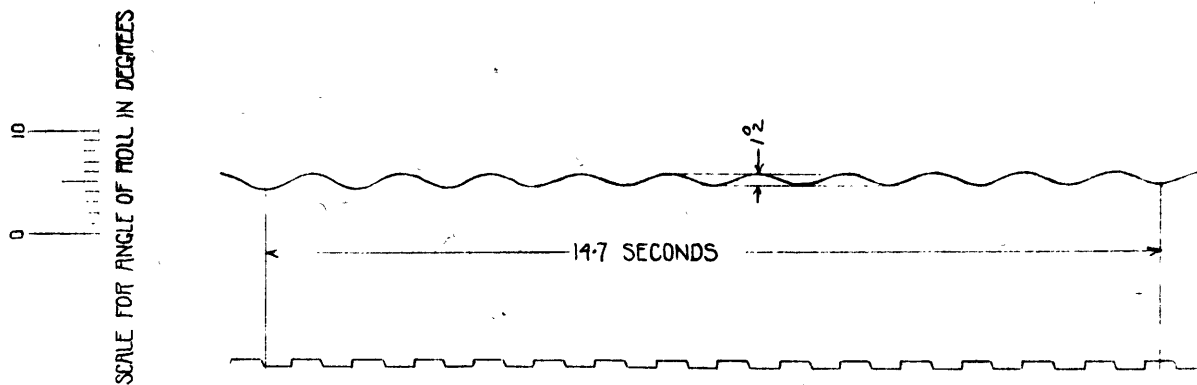
EXPERIMENTAL MODEL BASIN

NAVY YARD WASHINGTON D. C. FEB 1923



BALLAST WINGED OUT

	MODEL	SHIP
RADIUS OF GYRATION	1.5	27.6
PERIOD OF ROLL	1.79 SEC.	7.69 SEC.

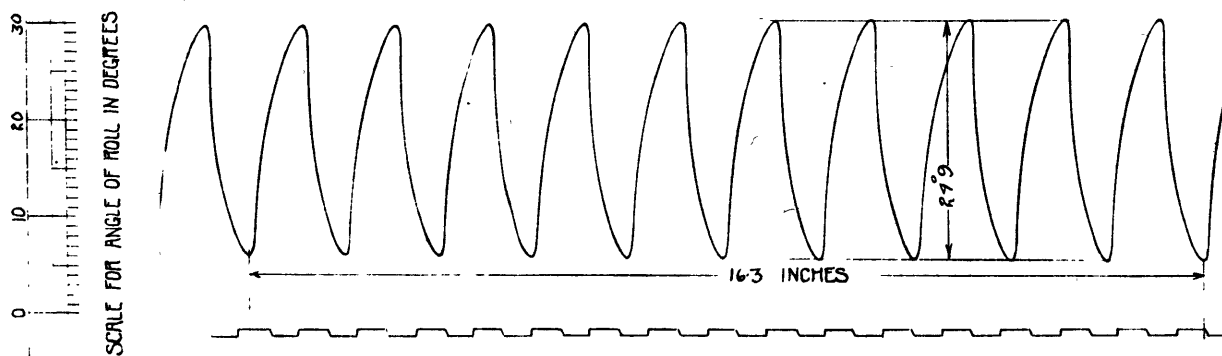


BALLAST CENTRALIZED

	MODEL	SHIP
RADIUS OF GYRATION	1.2	22.1
PERIOD OF ROLL	1.47 SEC.	6.31 SEC.

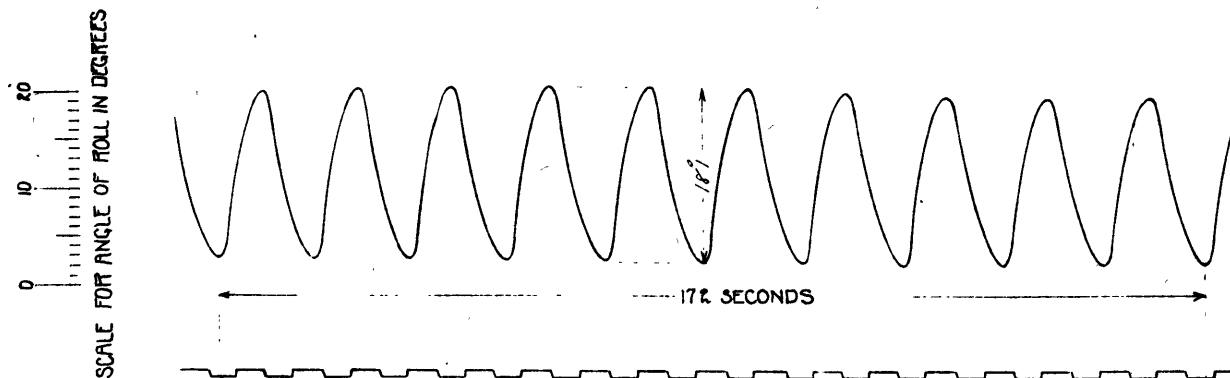
GYROSCOPIC ROLLING RECORDS
 FROM TEST OF
 MODEL N° R375 ROLLING IN WAVES
 MODEL REPRESENTS
 U.S. CRANE SHIP N° 1

RADIUS OF GYRATION	MODEL	SHIP
G. M.	1.357	2.5
DISPLACEMENT	4003 LBS	11,400 TONS
LINEAR RATIO SHIP TO MODEL	= 18.4	
ECCENTRICITY OF WAVE MAKER	= 2"	



BILGE KEELS OFF

	MODEL	SHIP
NATURAL ROLLING PERIOD	1.51 SEC.	6.48 SEC.
PERIOD OF WAVE	1.63 "	7.00 "

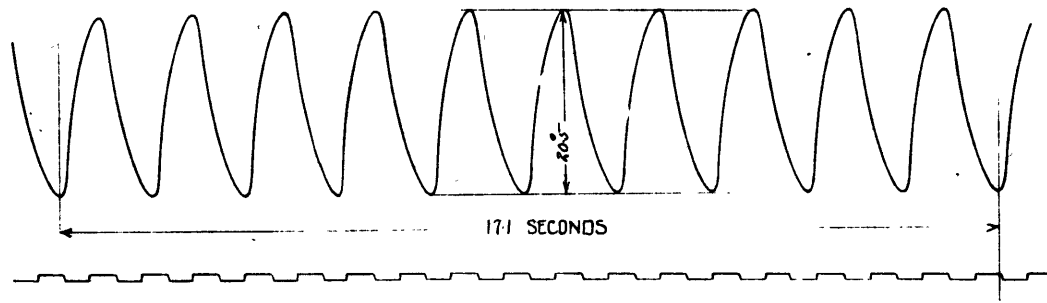
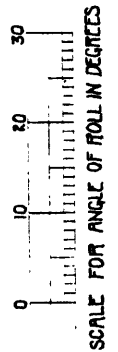


BILGE KEELS ON

	MODEL	SHIP
NATURAL ROLLING PERIOD	1.63 SEC.	7.00 SEC.
PERIOD OF WAVE	1.72 "	7.39 "

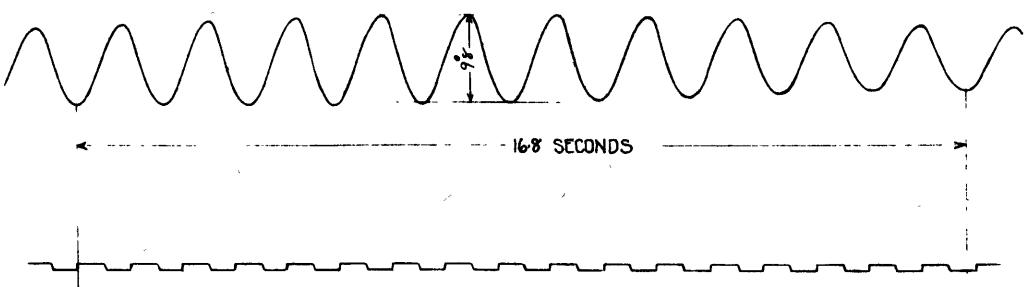
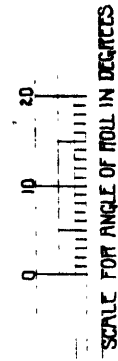
GYROSCOPIC ROLLING RECORDS
 FROM TEST OF
 MODEL N° 2375 ROLLING IN WAVES
 MODEL REPRESENTS
 U.S. CRANE SHIP N° 1

	MODEL	SHIP
RADIUS OF GYRATION	1.35'	25'
G.M.	1.092	20.1
DISPLACEMENT	4600 LBS	13,100 TONS
LINEAR RATIO, SHIP TO MODEL	18.4	
ECCENTRICITY OF WAVE MAKER	2"	



BILGE KEELS OFF

	MODEL	SHIP
NATURAL ROLLING PERIOD	16.5 SEC.	7.08 SEC.
PERIOD OF WAVE	17.1 "	7.34 "

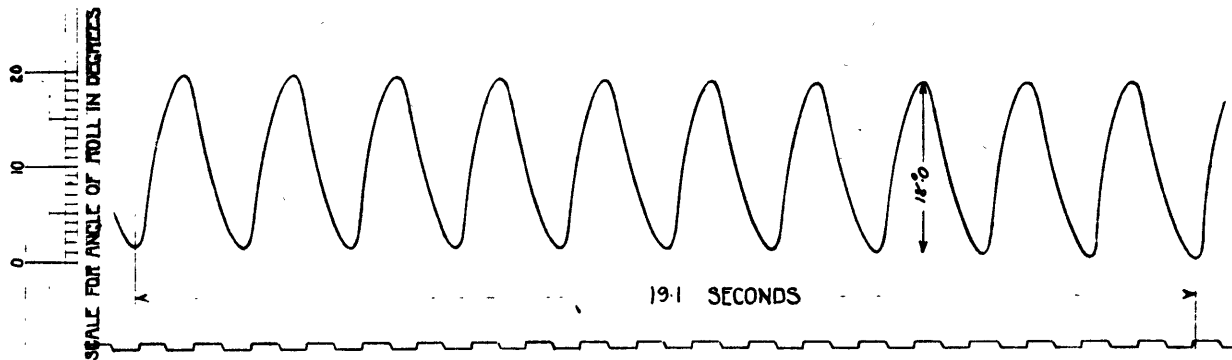


BILGE KEELS ON

	MODEL	SHIP
NATURAL ROLLING PERIOD	17.6 SEC.	7.55 SEC.
PERIOD OF WAVE	16.8 "	7.21 "

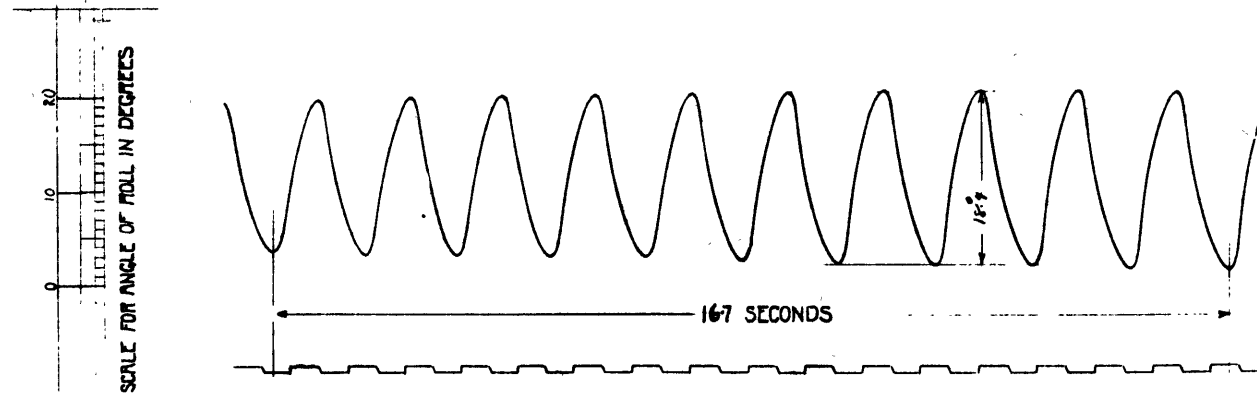
GYROSCOPIC ROLLING RECORDS
 FROM TEST OF
 MODEL N° 2375 ROLLING IN WAVES
 MODEL REPRESENTS
 U.S. CRANE SHIP N° 1
 BILGE KEELS OFF

	MODEL	SHIP
G.M.	1.092	20.1
DISPLACEMENT	1600 LBS	13,100 TONS
LINEAR RATIO SHIP TO MODEL	= 18.4	
ECCENTRICITY OF WAVE MAKER	= 2"	



BALLAST WINGED OUT

	MODEL	SHIP
RADIUS OF GYRATION	1.5	27.6
NATURAL PERIOD OF ROLL	1.79 SEC.	7.69 SEC.
PERIOD OF WAVE	1.91 "	8.20 "



BALLAST CENTRALIZED

	MODEL	SHIP
RADIUS OF GYRATION	1.2	22.1
NATURAL PERIOD OF ROLL	1.47 SEC.	6.31 SEC.
PERIOD OF WAVE	1.67 "	7.17 "



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