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THE DAVID W. TAYLOR MODEL BASIN
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ROLLING CHARACTERISTICS OF MODEL 3705
REPRESENTING USS BURTON ISLAND (AG88)

By

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ROLLING CHARACTERISTICS OF MODEL 3705 REPRESENTING USS BURTON ISLAND (AG88)

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INTRODUCTION

The Director of the David Taylor Model Basin requested that a study be made of the effectiveness of bottom bilge keels on a model of the U.S. Navy Icebreaker USS BURTON ISLAND (AG88). Reports from the operating personnel indicate that without bilge keels the vessel is almost untenable in a seaway. Model 3705, representing the icebreaker, was tested for roll without bilge keels, with the U.S. Coast Guard type bilge keels, and with similar keels located at the lowest practicable position. To establish its relative rolling characteristics the results of the tests were compared with rolling data on a model of the SALT LAKE CITY cruiser class CA26 to CA31. Declining-angle curves are shown for the various conditions. From these curves comparative roll-damping data have been derived.

MODEL TESTS

The basic conditions for the test were:

	AG88	Model 3705
Displacement	5316 tons	2839 lb
Metacentric height (GM)	5.68 ft	4.26 in.
Period of roll (zero speed)	9.5 sec	2.4 sec
Linear ratio of ship to model		16

The designed 18-in. bilge keels, called upper keels in this report, were installed in three sections in accordance with Reference (1).* The lower set of keels, which were of the same size, were positioned below Longitudinal 1 in the area where a West Coast docking report indicated that paint was not scoured off by ice. The location selected appeared to be free from interference with docking blocks. Both sets of keels are shown in Figure 1.

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* Numbers in parentheses indicate references on page 3.

The model was rolled by hand until a rolling angle of about 14° was obtained, whereupon the model was set free and the rolling was recorded by a gyro roll recorder.

For tests underway, the model was towed by a line about 10 ft long. The model showed lack of directional stability at 3 knots (12 knots full-scale) and tended to yaw off course. Data for this condition are omitted from this report.

TEST RESULTS

Rolling angles covered in this report are measured from the upright position to one side, whereas number of rolls refers to a complete rolling cycle of starboard-to-port-to-starboard or vice versa.

Declining-angle curves, plotted from the rolling records, for the bare-hull, upper-keel, and lower-keel conditions at zero speed are shown in Figure 2. The lower keels were somewhat less effective than the upper keels when the model was not underway.

The tests were repeated with the model being towed at 1 knot (4 knots full-scale). The declining-angle curves are shown in Figure 3. The lower keels were as effective as the upper keels at this speed.

Tests were run at 2 knots also, but results are available for the upper-keel condition only. A casualty to the roll recorder precluded collecting data for the lower-keel condition. The declining-angle curves for the bare-hull and upper-keel conditions are shown in Figure 4.

To establish relative rolling characteristics a comparison has been made between the bare-hull condition and the designed bilge-keel condition of Model 3705 and Model 2697, representing the SALT LAKE CITY cruiser class. The declining-angle curves shown in Figure 5 indicate that at zero speed the icebreaker hull is inherently more resistant to rolling than the cruiser type. The 36-in. bilge keels used on the cruisers were more effective, however, than the 18-in. keels used on the icebreaker. A more definite comparison is shown in Figure 6, in which roll damping per cycle is derived from the declining-angle curves.

DISCUSSION

In Reference (2) it was stated that numerous complaints had been received from the operating personnel of the excessive rolling of the cruisers. Presumably bilge keels small enough to be practicable in heavy ice would contribute somewhat to stabilizing the ship but in this respect would compare unfavorably with those used on the cruiser, which had already established a bad reputation among operating personnel.

In view of the unsuccessful experiences of the U.S. Coast Guard with the designed upper bilge keels, it seems unlikely that the lower keels, although possibly less apt to be ripped off by ice, would provide a satisfactory solution to the problem of rolling. In Reference (2) model tests on the cruiser showed that antiroll tanks were more effective than normal bilge keels at low speeds; therefore activated antirolling tanks would seem to be the most promising method of reducing the roll of the icebreaker.

CONCLUSIONS

The pertinent conclusions to be drawn from this study are:

1. The icebreaker hull is inherently more resistant to rolling than the SALT LAKE CITY cruiser class hull.

2. Bilge keels of the designed size, even if they could be located to escape demolition by ice, would provide roll-damping qualities inferior to those on the cruisers, which were considered unsatisfactory by operating personnel.

3. Stabilization by means of activated antirolling tanks seems to be the most promising method for improving the sea-kindliness of the icebreakers.

REFERENCES

(1) BuShips letter AG88(633-517) of 12 August 1948 to Commanding Officer, USS BURTON ISLAND (AG88).

(2) "Report of a Study with Models of the Rolling of Cruisers," EMB Report 295, May 1931.

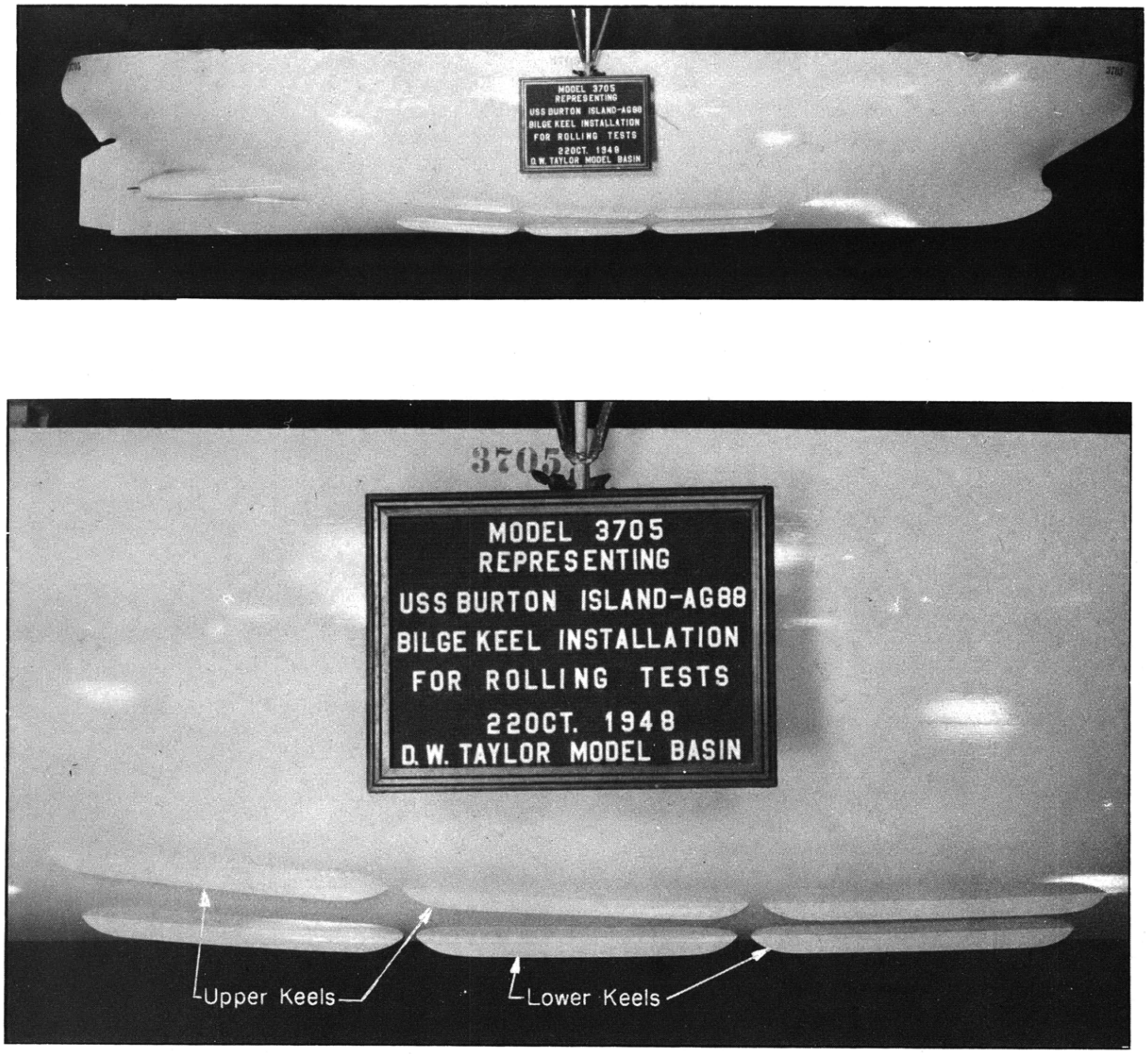

Figure 1 - Location of Upper and Lower Keels

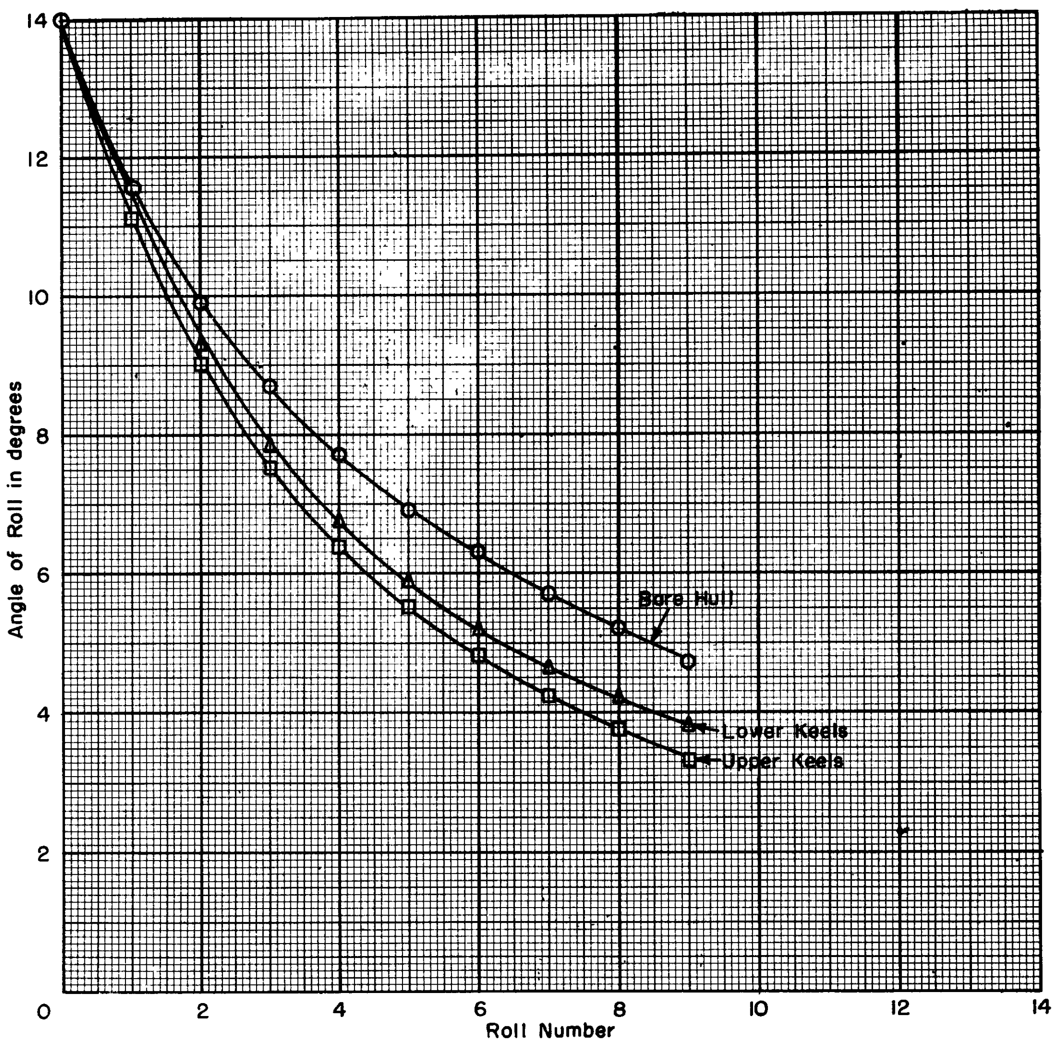

Figure 2 - Declining-Angle Curves for Model 3705 at Zero Speed

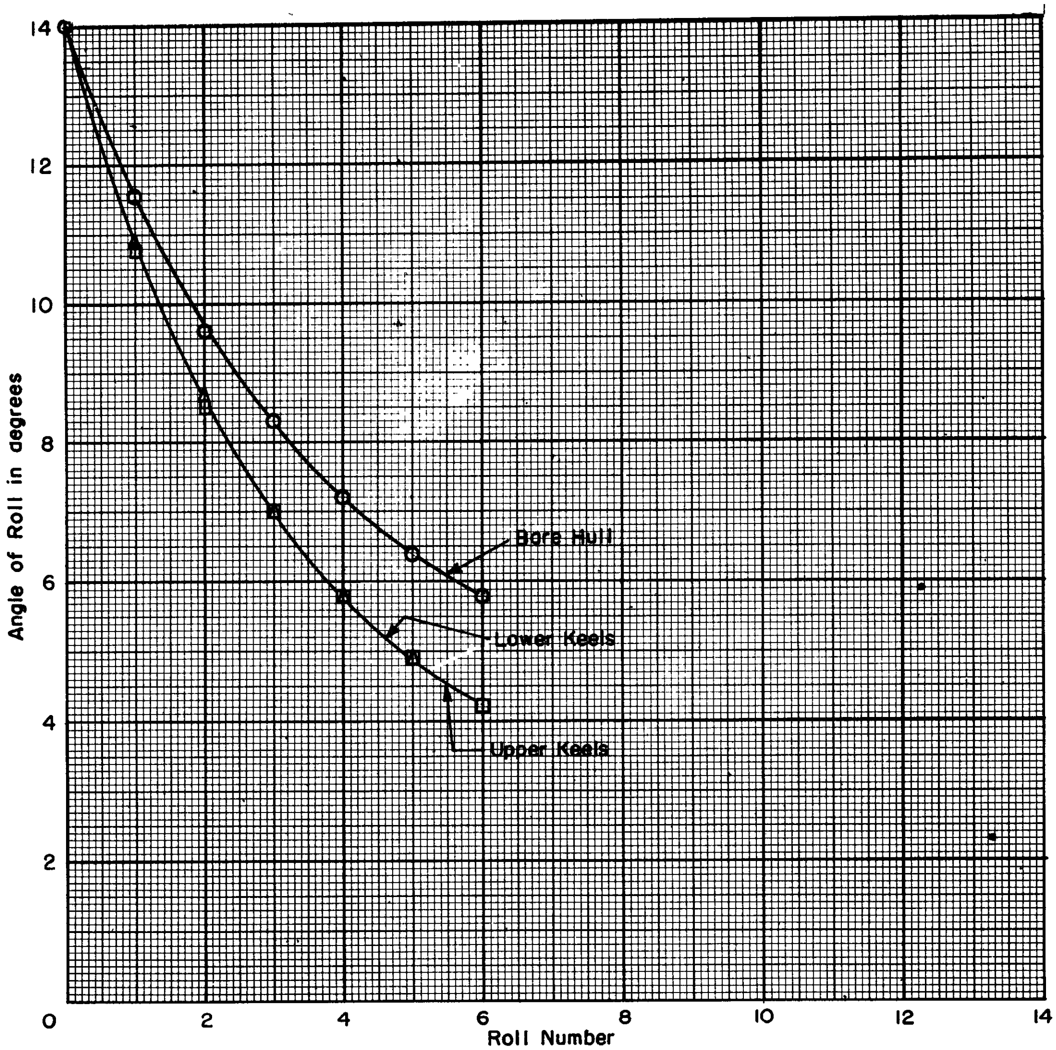

Figure 3 - Declining-Angle Curves for Model 3705 at 1 Knot

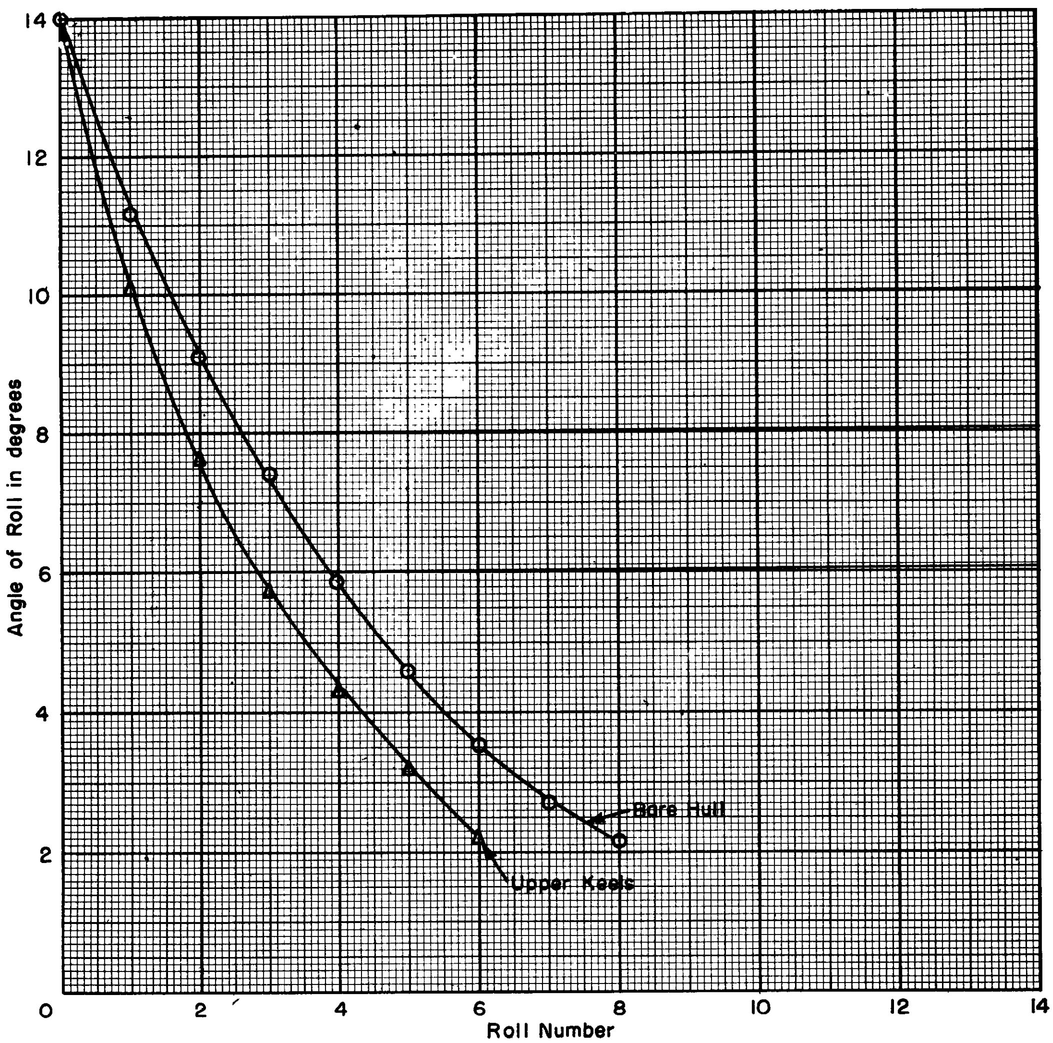

Figure 4 - Declining-Angle Curves for Model 3705 at 2 Knots

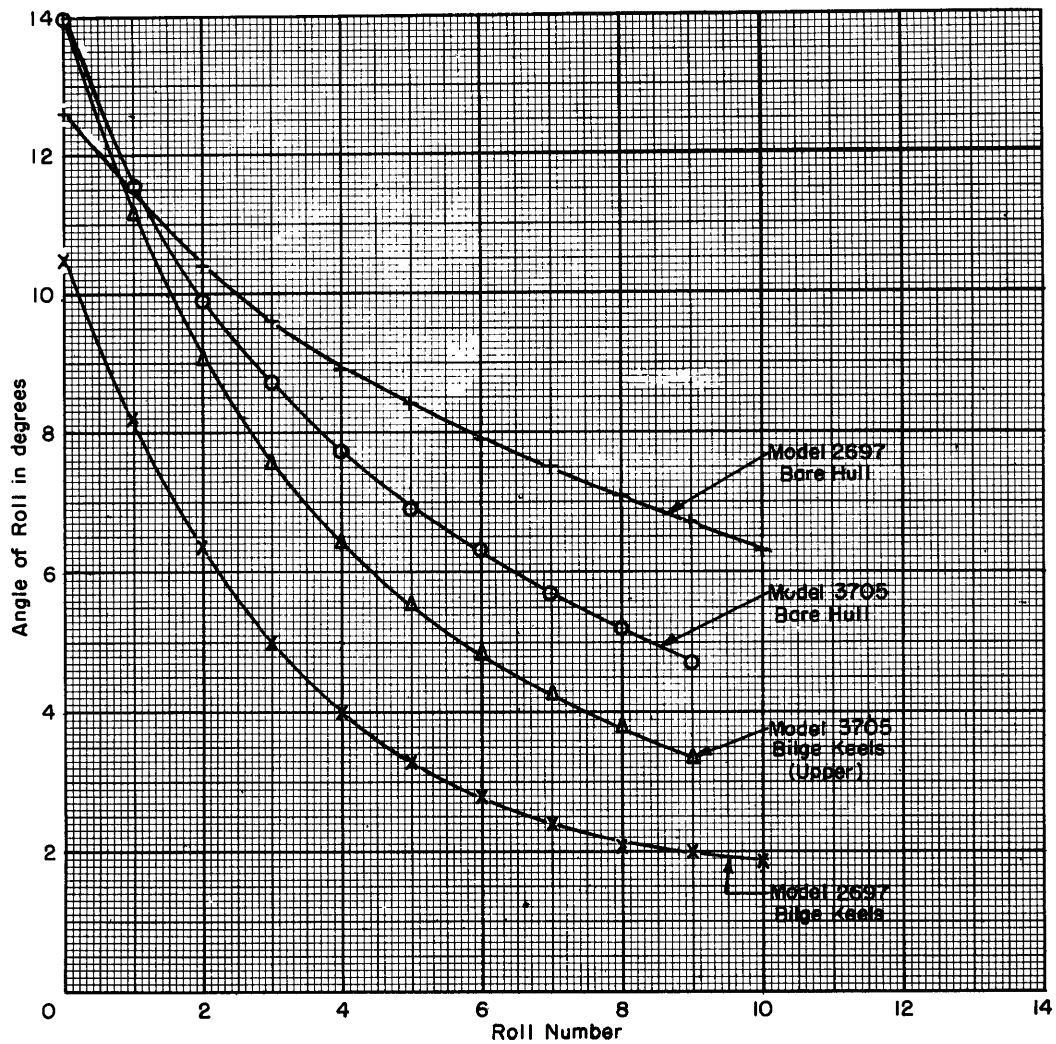

Figure 5 - Declining-Angle Curves for Models 3705 and 2697 at Zero Speed

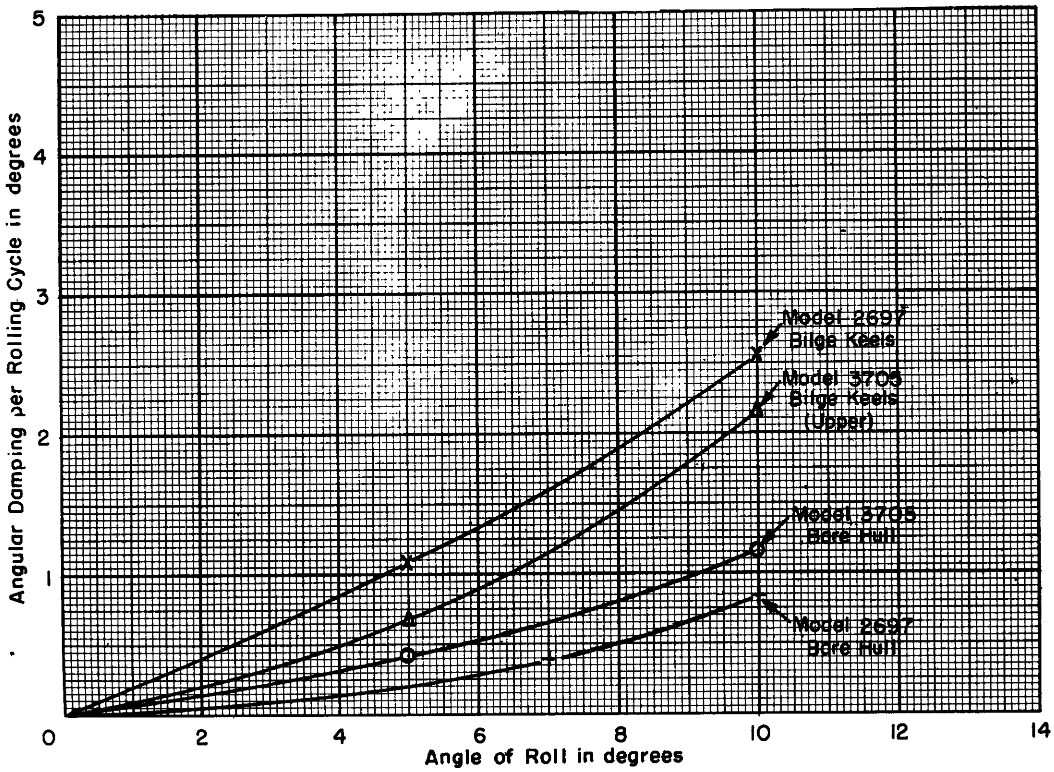

Figure 6 - Roll Damping of Models 3705 and 2697 at Zero Speed