International Journal of Offshore and Polar Engineering
Vol. 4, No. 3, September 1994 (ISSN 1053-5381)

On the Dynamics of Taut Oceanographic Surface Moorings

M.A. Grosenbaugh*
Department of Applied Ocean Physics and Engineering
Woods Hole Oceanographic Institution, Woods Hole, Massachusetts, USA

ABSTRACT

Oceanographic surface moorings, made from a combination of nylon rope and wire rope, are susceptible to high dynamic tensions. This is due to the fact that, when the length of the nylon rope is greater than 1000 m, the elastic natural frequency of the mooring coincides with the frequency range of ocean waves. Attaching large oceanographic instruments or masses to the upper portion of the mooring has little effect on the the elastic natural frequency and the shape of the mooring's transfer function. The only effect is a magnification of the dynamic tension by a factor that is equal to the combined mass of the wire rope and the attached instruments. The sensitivity of the dynamic response to the size and placement of attached instruments or masses can be greatly enhanced by using line of the same material throughout the mooring.

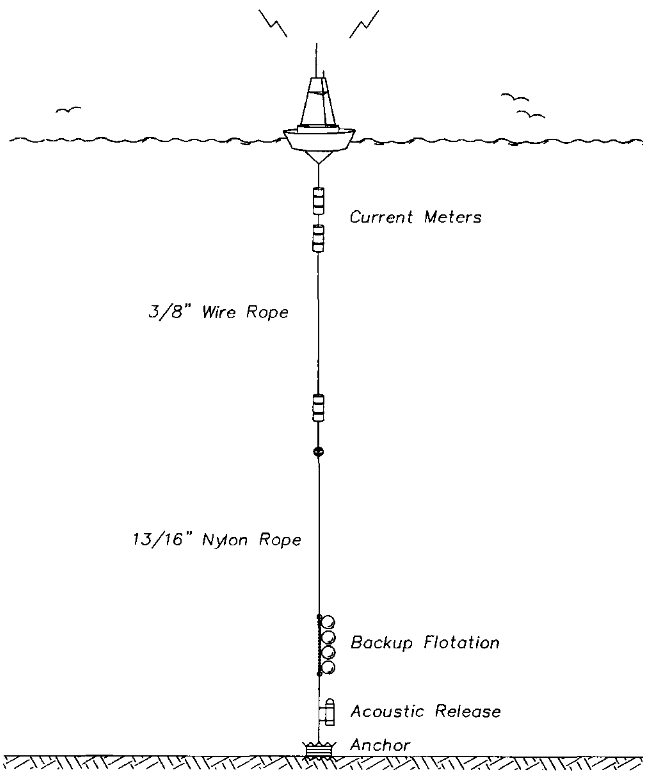

Fig. 1 Taut oceanographic surface mooring consisting of an upper section of wire rope to resist fish bites and a lower section of nylon rope to allow mooring to stretch in strong currents

INTRODUCTION

The taut oceanographic surface mooring (Fig. 1) was developed in the 1960s as a platform for oceanographic instruments and is still used widely today (Berteaux, 1976). The design is driven by the desire to limit the angle of inclination of the attached instruments to less than 15° in a current and to prevent tangling of the mooring line under slack conditions. This is accomplished by placing nylon rope in the lower portion of the mooring to act as a shock absorber. The total original length of the mooring line, wire rope plus nylon rope, is set approximately equal to the depth. Thus, when there is no current, the mooring is taut, and this prevents kinks from forming in the wire. In a strong current, the nylon rope stretches to accommodate the increased load.

The ability of the nylon rope to stretch significant amounts under moderate tensions is what makes it ideal for handling static loads.However, the trade-off is that the elastic natural frequency of the mooring is reduced, and, for long lengths of nylon rope, the natural frequency becomes dangerously close to the frequency range of ocean waves. If the elastic natural frequency coincides with the ocean-wave zone, there could be resonance, in which case the dynamic tensions of the mooring will be amplified, causing fatigue of the mooring components.

From our own full-scale experimental measurements of the tension of a taut oceanographic surface mooring, we found that resonance does occur. Fig. 2 shows the dynamic-tension power spectrum of the Marine-Light Mixed-Layer (MLML) pilot mooring

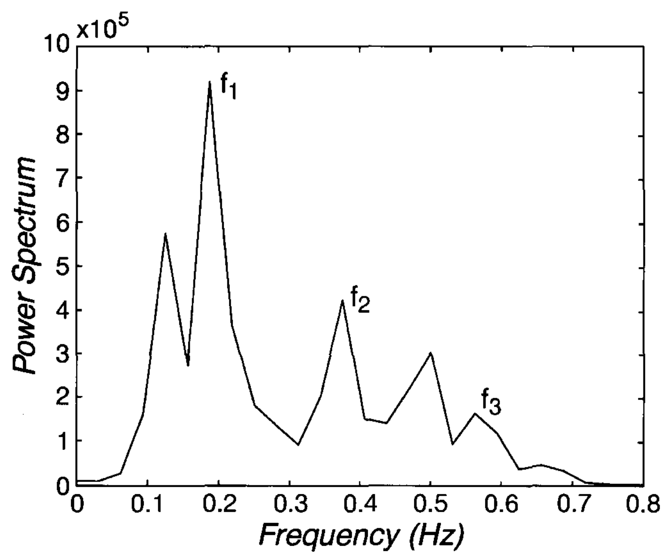

Fig. 2 Power spectrum of dynamic tension of 1989 MLML pilot mooring. Fundamental natural frequency and 2 lowest harmonics are marked f_1, f_2, and f_3, respectively.

*ISOPE Member.

Received July 14, 1993: revised manuscript received by the editors December 10, 1993. The original version was submitted directly to the Journal.
KEY WORDS: Oceanographic moorings, surface moorings, cable dynamics.