EXPERIMENTAL SCALE MODEL STUDY OF LORAN-C SIGNALS NEAR BRIDGES

Valdis V. Liepa and Robert L. Frank (consultant)
Radiation Laboratory
Department of Electrical and Computer Engineering
The University of Michigan
Ann Arbor, Michigan 48109

It has been observed that Loran-C errors of significant magnitude are encountered near large bridges, such as the Golden Gate Bridge, with correspondingly smaller and more localized errors near smaller bridges [1]. The errors are attributable to interactions of the Loran-C singals (100 kHz) with the structure, and here we report our laboratory experimental study by which these errors were quantified using a small scale bridge model over an aluminum ground plane.

The measurements were made in an anechoic chamber and for these it was necessary to construct a vertical ground plane that could be illuminated near edge-on incidence. Figure 1 shows the ground plane. It was circular with resistive sheet extension to reduce edge reflections. The illumination was from the right with the electric vector pointing out of the paper. The bridge (Fig. 2) was then mounted on the ground plane and the different directions of incidence on the bridge were obtained by rotating the bridge. The bridge was designed to represent a generic class of large suspension bridges and was chosen to model approximately the Golden Gate Bridge on a scale of 1:4250.

The normal electric field to the ground plane (i.e., the vertical field in real world Loran-C situations) was measured using a short monopole for 92 different situations defined by measurement locations relative to the bridge and directions of illumination upon the bridge.

For each situation, amplitude and phase data were recorded over the 118-500 MHz range and these were normalized in form E_n/E_{no}, where E_n is the normal electric field with the bridge present, and E_{no} is the corresponding field without the bridge. An amplitude of 1.0 and phase of zero degrees would indicate no signal interaction with the bridge.

Figure 3 shows a typical data set produced as a function of frequency. In this case the incidence is broadside to the bridge and the field was measured on the illuminated side at a distance of 0.5 of the span (between the inner towers). Such data can be applied to most any size bridge by applying appropriate scaling factors. For example, for the Golden Gate Bridge the equivalent

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scaled frequency is 425 MHz and there $E_n/E_{no} = 0.95 \underline{/12°}$, which implies as much as 100m positioning error. Data such as these can be sumarized on polar plots for given directions of incidence relative to the bridge. This is shown in Fig. 4. In this figure, the bridge is vertical and the incidence is from the right. The particular measurement given in Fig. 3 is at R = 2 and $\theta_B = 90°$. As expected, close to and underneath the bridge the phase errors are maximum.

More detailed description of the study and complete data can be found in [2].

References

[1] Illgan, J. D. and D. A. Feldman, "Loran-C signal analysis experiment--and overview," Proc. 7th Annual Technical Symposium of the Wild Goose Association, New Orleans, 12-20 October 1978.

[2] Liepa, V. V. and Robert L. Frank, "Study of reradiation of Loran-C in a harbor environment," University of Michigan Radiation Laboratory Report No. 018958-1-F, AD-A-120624, June 1982.

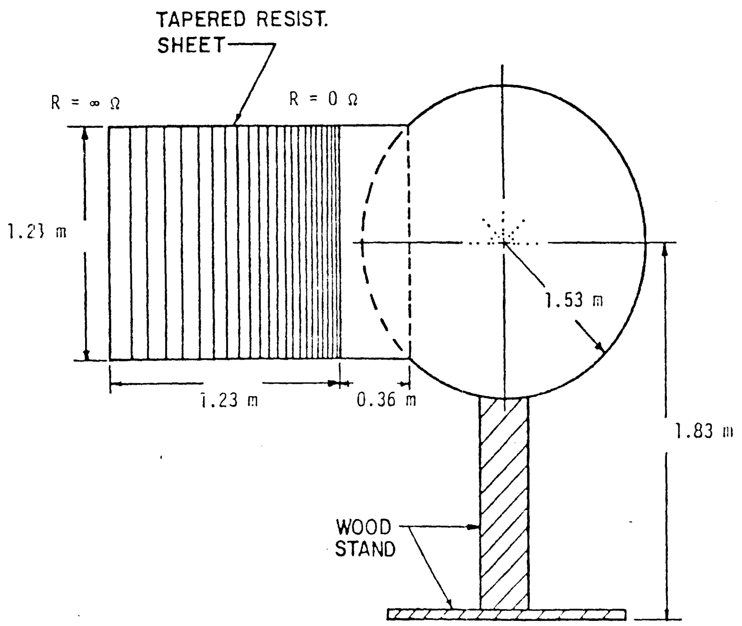

Fig. 1: Circular ground plane configuration with resistive sheet extension.

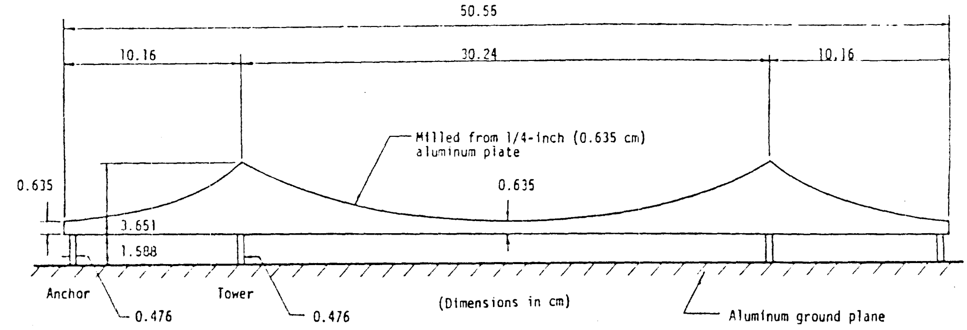

Fig. 2: Bridge model used in the measurements.

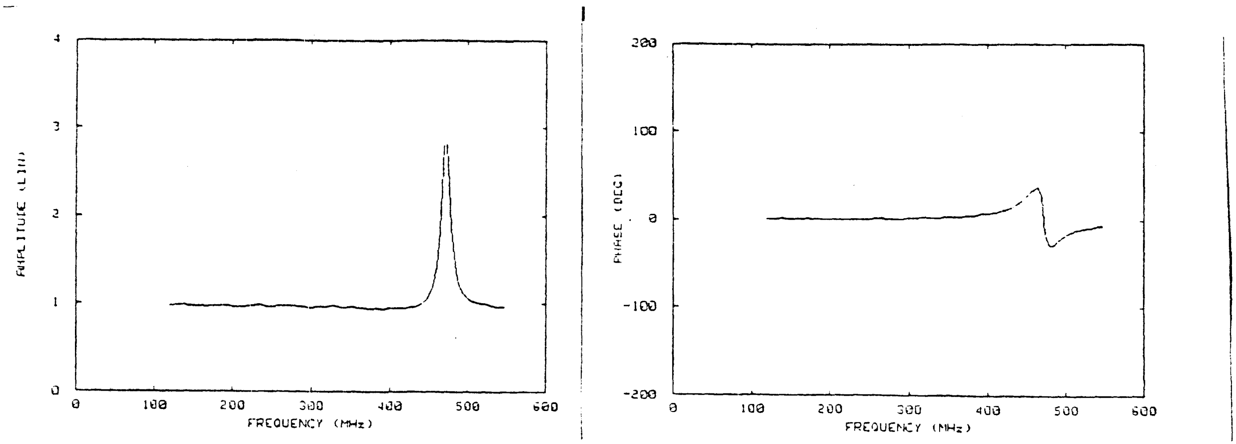

Fig. 3: Measured frequency response.

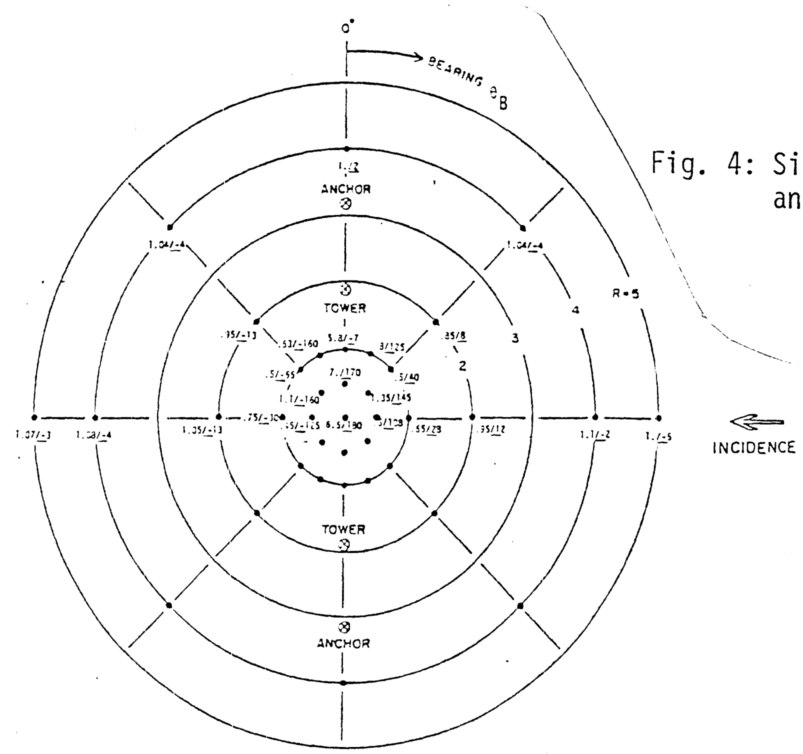

Fig. 4: Signal amplitude and phase errors.