LABORATORY COUPLING TESTS FOR OPTIMUM LAND STREAMER DESIGN OVER SAND DUNES SURFACE

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SUMMARY

The cost of data acquisition in land is becoming a major issue as we strive to cover larger areas with seismic surveys at high resolution. Over sand dunes the problem is compounded by the week coupling obtain using geophones, which often forces us to bury the phone. A major challenge is designing such a land streamer system that combines durability, mobility and the required coupling. We share a couple of such designs and discuss the merits behind such designs and test their capability. The testing includes, the level of coupling, mobility and drag over sand surfaces. For specific designs loose sand can accumulate inside the steamer reducing its mobility. On the other hand, poor coupling will attenuate the high frequencies and cause an effective delay in the signal. The weight of the streamer is also an important factor in both mobility and coupling as it adds to the coupling it reduces the mobility of the streamer. We study the impact of weight and base plate surface area on the seismic signal quality, as well as the friction factor of different designs.

Key words: Land-streamer , Geophone Coupling.

INTRODUCTION

When seismic surveys are conducted on sand it is necessary to plant a large number of spiked geophones at equally spaced intervals to form a spread. Individually planting geophones in this conventional manor inherently takes time and requires considerable numbers of field personnel, which adds up to increased costs. If utilizing marine survey techniques can reduce the acquisition time then the costs incurred to conduct a survey will be markedly reduced. Land streamers were shown to be promising in snow covered areas (Determann et al.,1988, Eiken et al.,1989). More recent tests on roads and fields by van der Veen et al. (1998) and paved areas by Inazaki (1999) have found that land streamer sensors can obtain comparable results to traditional spiked geophones. One of the challenges of designing such a land streamer is to guarantee the desirable coupling of the geophone with the ground surface, while marinating mobility. Although ground coupling is undoubtedly the biggest obstacle we need to overcome for sand streamers to produce comparable results to spiked geophones, there is another inherent problem which also needs to be addressed. That is terrain variations, or more to the point, maintain the vertical orientation of the individual geophone that comprises the sand streamer. Rugged or uneven terrain conditions will more than likely cause the geophone elements to move away from their required vertical plane orientations, greatly reducing their response. However, that's not all; the situation becomes even more of a dilemma when one realizes that ground coupling will also be affected. This situation is possibly the biggest problem facing the sand streamer concept and it needs to be considered before attempting to design an effective sand streamer. Moreover, we will need to address several other potential problems in designing a sand streamer including friction and sand accumulation over sand streamer, which means increased weight, and larger pulling force is required.

Enhancing geophone ground contact by placing the land streamer sensors in a furrow (van der Veen and Green, 1998) or adding a rubber mat on top of the streamer to provide a hold down weight (van der Veen et al., 2001), were both found to be beneficial in improving signal quality in the field. We need to find a solution to the problems of ground coupling and terrain dependence, in order to make the land streamer concept a feasible approach to acquiring seismic data. We will address the problem of ground coupling by investigating the effects of weight and gravity. Problems with maintaining vertical coil orientations can be solved by designing a geophone mount that it will automatically level itself no matter what terrain conditions are present.

METHOD AND RESULTS

Geophone Ground-coupling is intuitive that increasing the weight of the streamer enhances coupling. However, increased weight will negatively affect mobility of the streamer (a major objective for reducing cost). To find the optimum weight to use was achieved through conducting numerous experiments with differently weighted mounts. In this project, different weights of geophone mounts is used to establish the relationship between mount weight and ground. The results of such experiments are expected to help in choosing a suitable (if not optimal) weight for our design.

A number of experiments were conducted to see if a signal could be recorded for each of the prototype geophone mounts. Initial tests were conducted in the lab to determine whether the prototype geophones mount could produce a response. Figure 1 illustrates the initial test conducted within the lab. We placed one of the streamer designs and a weight drop like source generator.

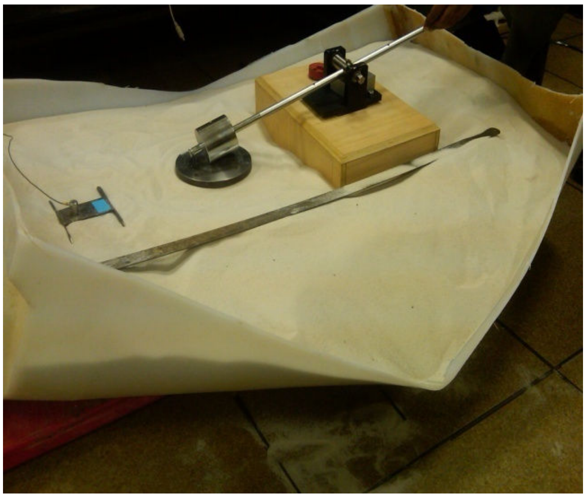

Figure 1: A picture of a container of Sand that includes the streamer to the left and the source to the right.

However, we faced a problem with this setup. Specifically, when data ware analyzed, a problem with the precision was found due to inconsistency in the hammering force. To solve this problem a mechanical setup was designed which consists of a track with a hole in the middle, a solid metal ball and a stand as shown in Figure 2. The metal ball rolls on the track and falls through the hole freely to hit a metal base creating a constant hammering force that should be consistent.

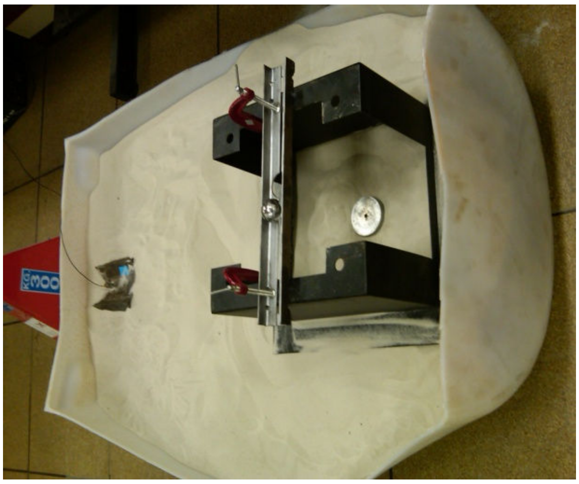

Figure 2: A picture of the experiment in which we used a rolling ball for a source to maintain consistent force.

The test was repeated three times for each streamer design and the average coupling value was computed in an effort to determine which mount produced the best results. Analysis for the different shapes, at a distance of 30cm from center of impact to geophone center, is shown in Table 1. The best results were achieved using S2L and S6, respectively, as illustrated in Table 1 along with pictures of the streamer designs used.

Measuring of the coefficient of friction involves two quantities, F the force required to initiate and/or sustain sliding (impending motion force), and N, the normal force holding the two surfaces together. A simple device can be designed to measure the impending force F to start the motion which is greater than the force required to sustained the motion (the kinetic friction force): This devise is called the pulleys weights system as shown in Figure 3.

A weight P is applied gradually until sliding begins, then the weight P is equal to the impending force (pulling force) and the static coefficient of friction $\mu_s = P/N$, where N is the weight of the sliding object. The result of pulling force is illustrated in Table 2 along with the weight of geophone mounted plate

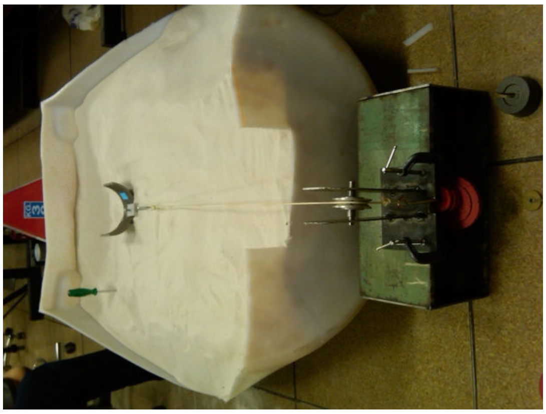

Figure 3: Pulleys-weights experimental setup for friction

Sample #	Weight (g)	Pulling Force (N)
S1	587	17
S2H	1213	11
S2L	530	7
S3	427	5
S4	792	6
S5	1450	27
S6	1008	12

Table 2:measurements of weight and its pulling force of geophone mounted plate.

CONCLUSIONS

The challenges of designing a sand streamer are to guarantee desirable coupling of the geophone with the ground surface, minimum friction and less sand accumulation over land streamer. These problems have been addressed and tested by the proposed design S2L that achieved a better coupling and a satisfactory pulling force compared to other designs. A number of experiments were conducted on seven different designs of geophone mounted plates show that the best coupling results were achieved using designs “S2L” and “ S6”, respectively. Also, friction tests show that S2L design given by the cylindrical tube like surface has one of the lowest pulling forces among other designs.

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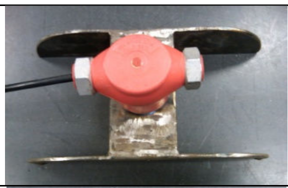
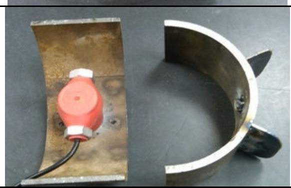
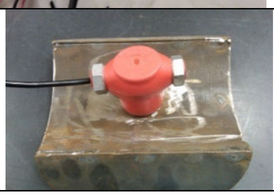
Sample #	Shape	Repetitions		Average (v)
S1		a	0.4106	0.4801
		b	0.4569	
		c	0.5729	
S2H		a	0.4176	0.4502
		b	0.4762	
		c	0.4567	
S2L		a	0.696	0.7302
		b	0.7253	
		c	0.7692	
S3		a	0.5739	0.5837
		b	0.6081	
		c	0.569	
S4		a	0.4176	0.5696
		b	0.6471	
		c	0.6442	
S5		a	0.4811	0.6113
		b	0.6276	
		c	0.7253	
S6		a	0.6081	0.6813
		b	0.6813	
		c	0.7546	

Table1: Analysis for different shapes at a distance of 30cm center to center