# CHAPTER 86

## ENGINEERING PROPERTIES OF SEA FLOOR SEDIMENTS FROM LA JOLLA CANYON

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### Abstract

Near surface sea floor sediments were obtained by the tracked underwater vehicle RUM from four locations on the floor of the La Jolla Canyon. The sediments were clayey silts of high plasticity. The engineering properties of the sediments, including grain size, index properties, strength and compressibility, were determined.


### Introduction

This paper covers the engineering properties of sediment samples from four locations on the floor of the La Jolla Canyon, north of San Diego on the Pacific coast, at waters ranging in depth from 1256 feet to 1334 feet. The samples were taken by a 2.875 in. in diameter, 22 in. long sampler attached to the RUM (Remote Underwater Manipulator), a research vehicle of the Marine Physical Laboratory of the Scripps Institution of Oceanography, University of California.

The RUM, (Fig. 1), is an unmanned tracked vehicle designed for sea floor explorations in water depths of more than 6000 feet (1,2,3). An umbilical cable connects RUM with a surface support platform. RUM has been equipped with a remotely controlled sediment corer, vane shear device, (Fig. 2), and cone penetrometer, (Fig. 3). A description of the sampling and in situ testing operations by RUM on the floor of the La Jolla Canyon was given by Anderson et al (3). Fig. 4 shows the sample locations. Water depths and the burial depths of the samples are given in Table 1.

Table 1 - Site Data

| Sample | Location | Water Depth Feet | Burial Depth Inches |
|---|---|---|---|
| A-5 | 1 | 1256 | 8 |
| B-6 | 2 | 1369 | 9 |
| C-8 | 3 | 1275 | 13 |
| D-9 | 4 | 1334 | 6 |


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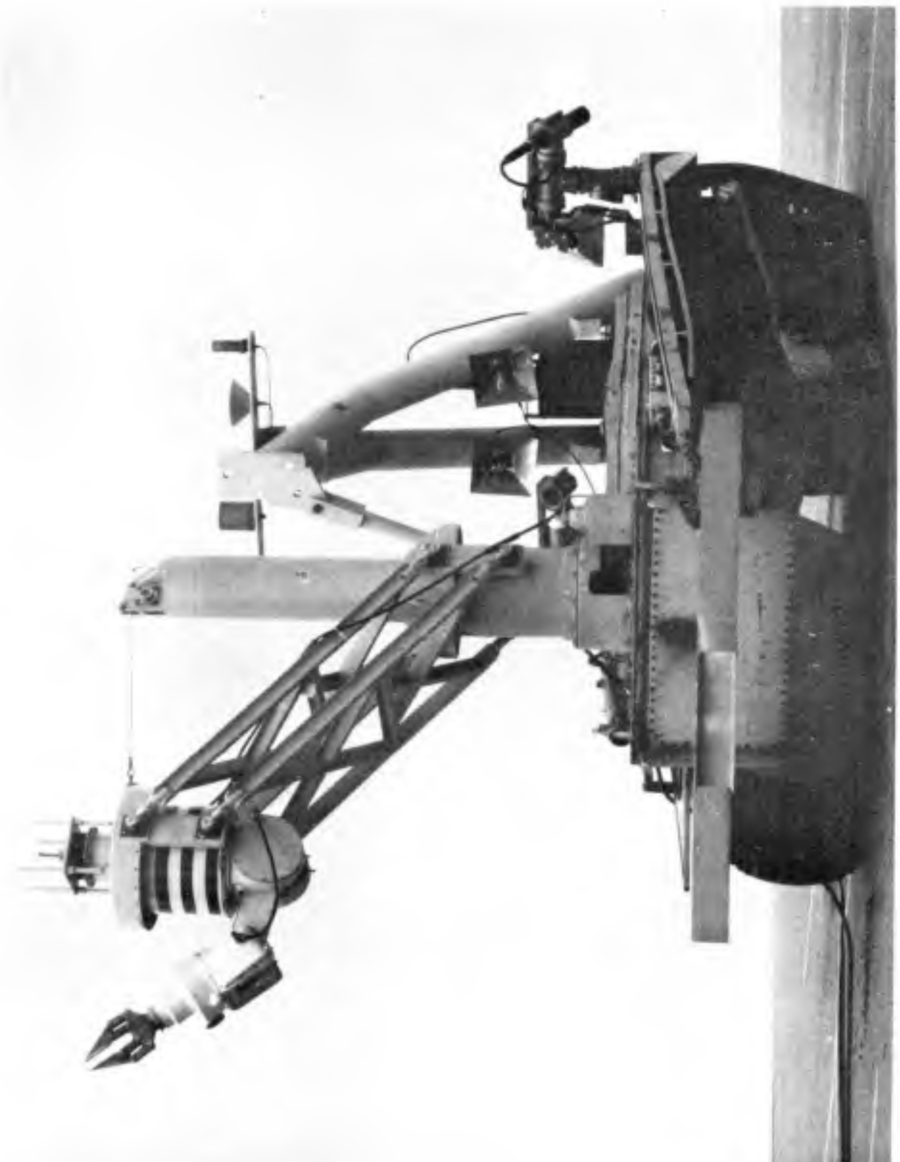

FIG. 1 THE RUM (COURTESY OF MARINE PHYSICAL LABORATORY, SCRIPPS INSTITUTION OF OCEANOGRAPHY, UNIVERSITY OF CALIFORNIA, SAN DIEGO)

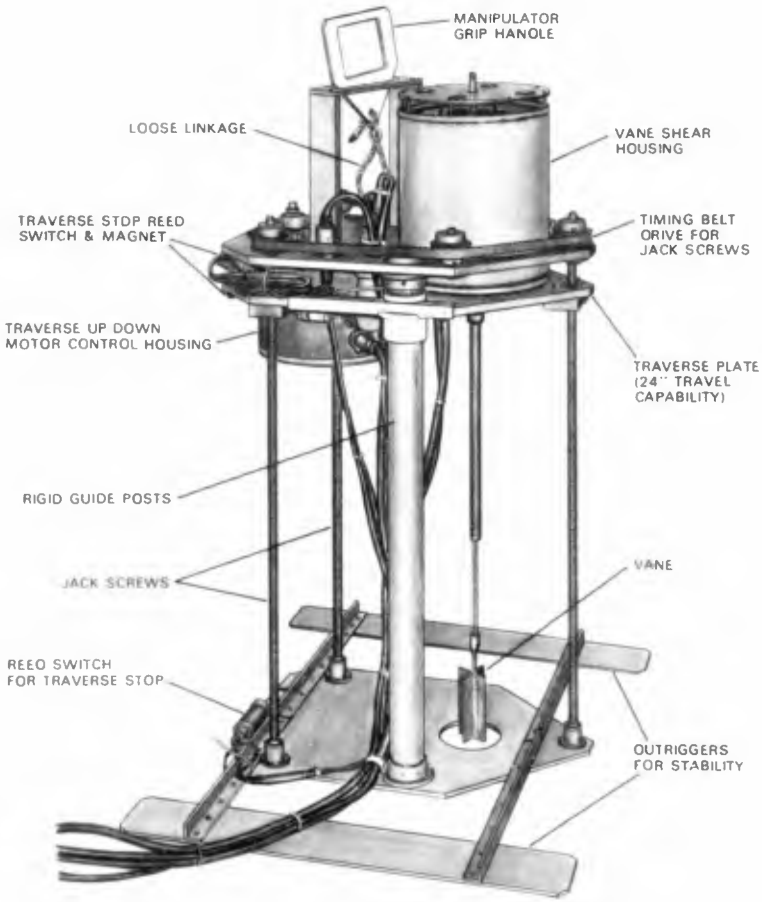


FIG. 2 THE RUM VANE SHEAR DEVICE

(COURTESY OF MARINE PHYSICAL LABORATORY, SCRIPPS INSTITUTION OF OCEANOGRAPHY, UNIVERSITY OF CALIFORNIA, SAN DIEGO)

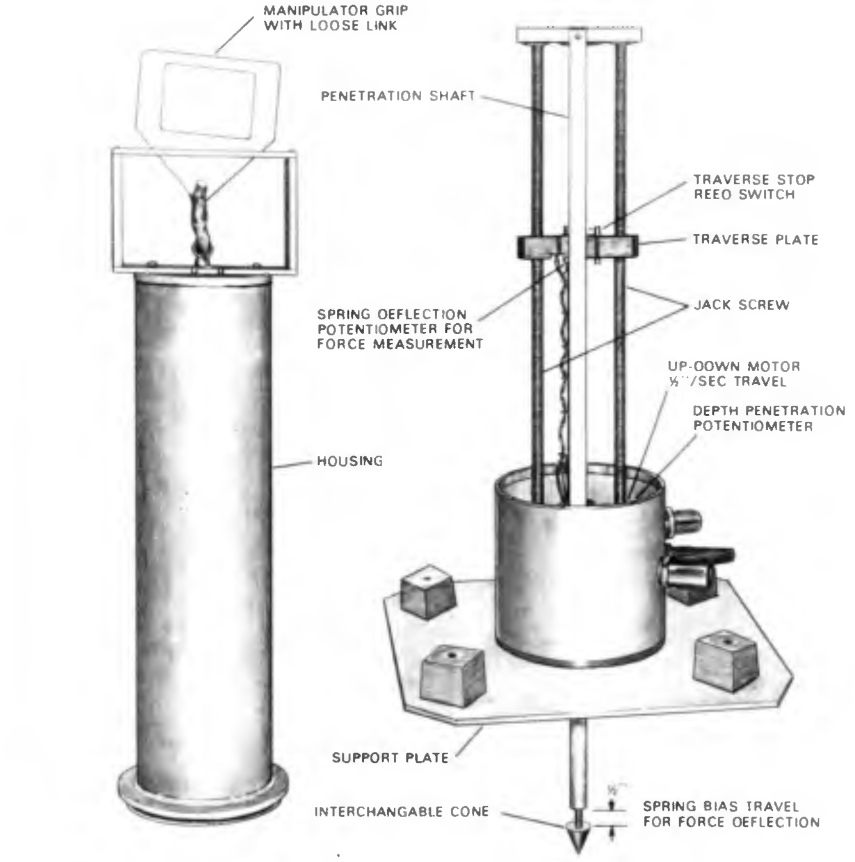


FIG. 3 THE RUM CONE PENETROMETER

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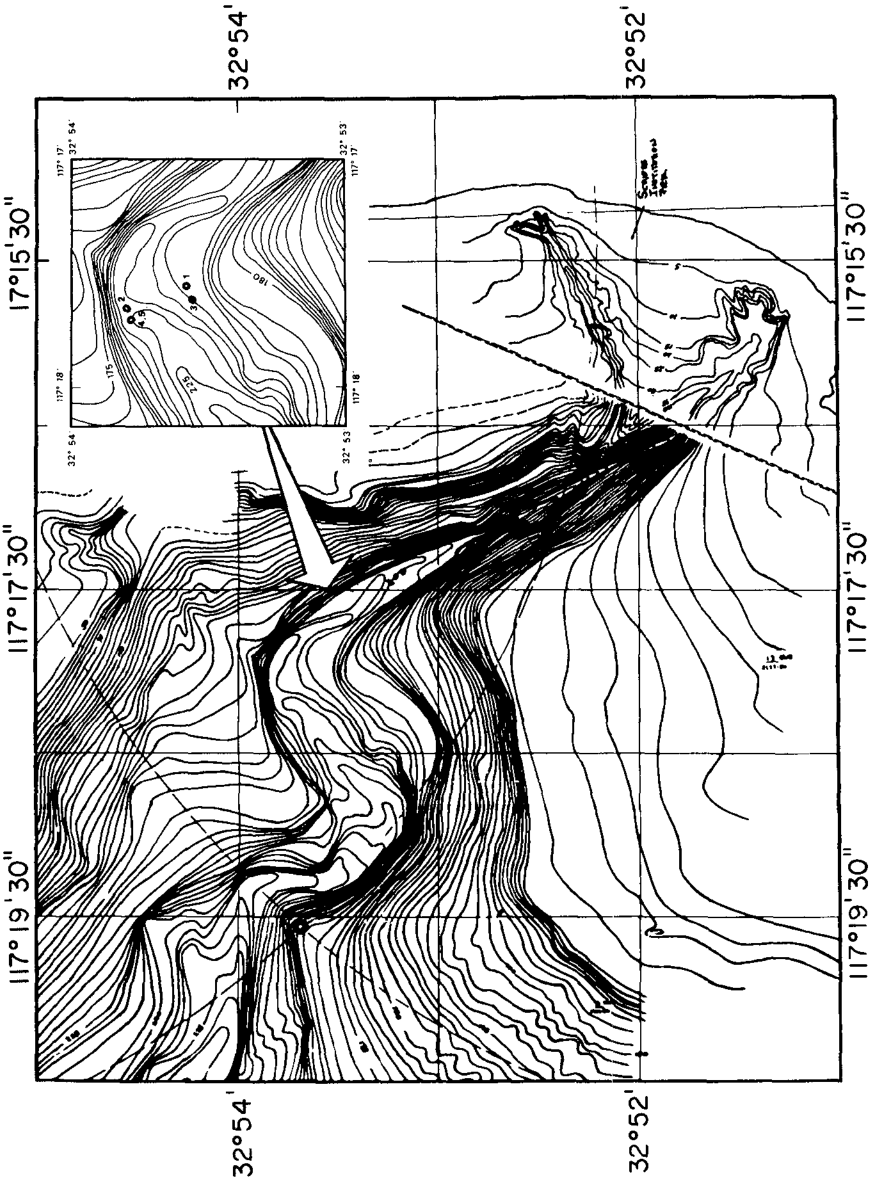


FIG. 4 SAMPLE LOCATIONS IN LA JOLLA CANYON (FROM REF. 3)

## Index Properties

The samples recovered were gray-green organic clayey silts of high plasticity which classify as MH-OH according to the Unified Classification System. The gradation curves, (Fig. 5), for the samples indicated 86 to 94 percent material finer than 0.074 mm (U.S. Standard Sieve No. 200), and approximately 5 percent clay size material (finer than 2 microns). The index properties of the sediments are given in Table 2. The water contents listed might be slightly lower than the in situ values because the samples were very soft and tended to compress under their own weights in the sampling tube during the storage period prior to testing. This may be the main reason for the differences between the water contents reported in Tables 2 and 3.

Table 2 - Index Properties*

| Sample | w % | $G_s$ | S % | $\gamma$ pcf | $\gamma_d$ pcf | $w_L$ | $I_p$ | LI |
|---|---|---|---|---|---|---|---|---|
| A-5 | 106.6 | 2.75 | 99.9 | 90.0 | 43.7 | 84 | 44 | 1.5 |
| B-6 | 108.1 | 2.70 | 100.0 | 90.3 | 43.3 | 81 | 39 | 1.4 |
| C-8 | 96.9 | 2.70 | 100.0 | 92.5 | 46.8 | 71 | 33 | 1.9 |
| D-9 | 97.5 | 2.73 | 99.3 | 91.5 | 46.4 | 77 | 33 | 1.6 |

* w is water content (ratio between weight of water and weight of solids); $G_s$ is specific gravity of solids; S is degree of saturation; $\gamma$ is unit weight; $\gamma_d$ is dry density (ratio between the dry weight and total volume); $w_L$ is liquid limit; $I_p$ is plasticity index and LI is liquidity index.

## Shear Strength

The undrained strength of each sample, determined by laboratory vane shear test, is given in Table 3. Fig. 6 shows a typical result of the laboratory vane shear test. The value of shear strength measured on sample D-9 appears high because of the reduction of water content caused by compression of the sample under its own weight in the sampling tube during the storage period. Sensitivity (the ratio between the undisturbed strength and fully remolded strength) values of 2 to 4 indicate "medium sensitivity." However, the actual sensitivities might be higher since disturbance and other changes caused by sampling and handling undoubtedly decreased the undrained strength of the samples. In situ vane shear tests by the RUM (3) in location No. 3 indicated a shear strength of approximately 0.5 psi at a depth corresponding to the burial depth of sample C-8 for which the laboratory vane shear was 0.3 psi.

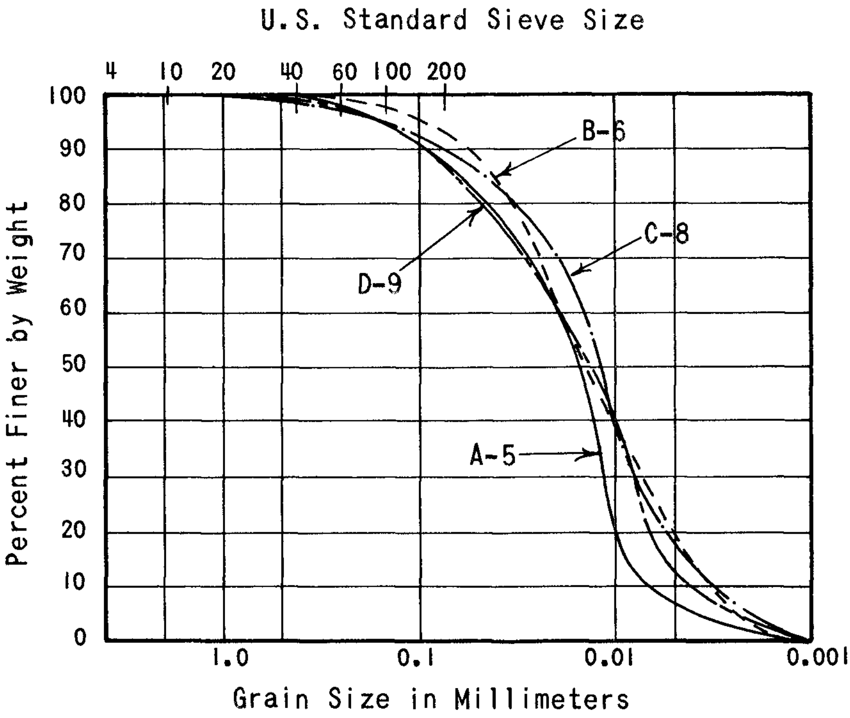


FIG. 5 GRADATION CURVES

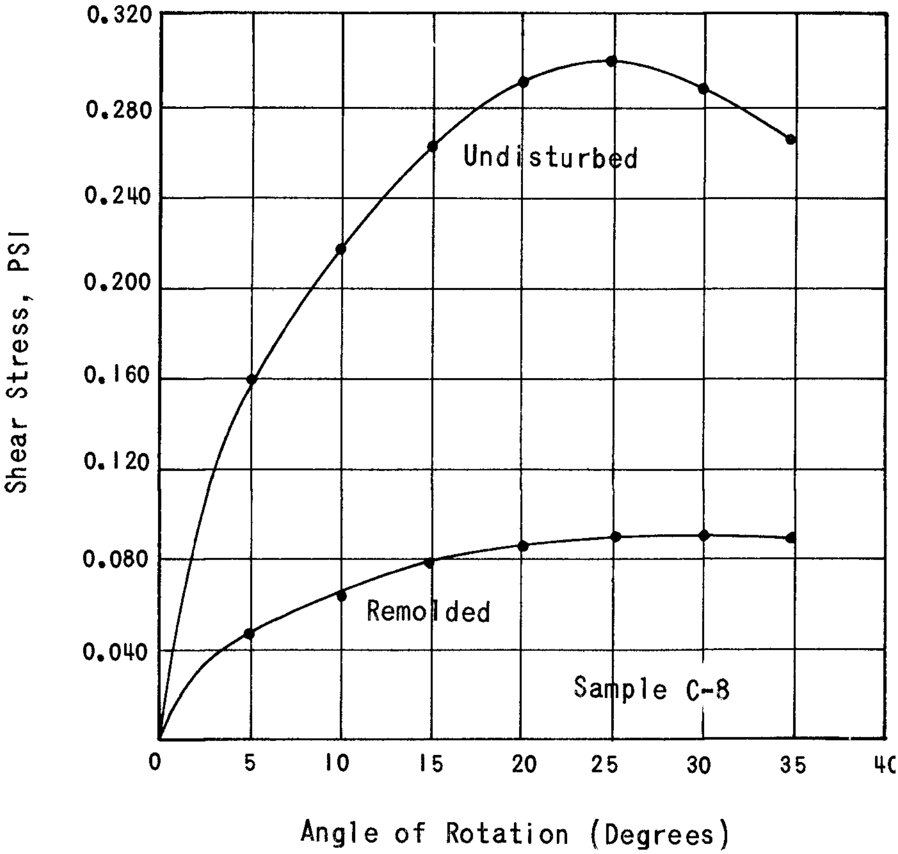


FIG. 6 RESULTS OF VANE SHEAR TEST

Compressibility

Consolidation tests were performed on 2.5 in. in diameter, 1 in. thick samples using a load increment ratio $\Delta p/p=1$, starting at a low stress of about 0.015 $Kg/cm^2$ (0.21 psi). Fig. 7 shows a typical result of consolidation test. Data from consolidation tests are summarized in Table 4. Fig. 8 shows a comparison between the compressibility characteristics of the clayey silt sea floor sediments tested and those of soft clays. The somewhat lower compressibility properties of these sediments are partly due to their high silt content. However, the values of the compression indices in situ might be higher than those determined from the samples because of the influence of sampling and disturbance on the compressibility characteristics of these sediments.

Table 3 - Undrained Shear Strength

| Sample | Location | Water Content % | Vane Shear Strength, Su psi | Sensitivity |
|---|---|---|---|---|
| A-5 | 1 | 113 | 0.13 | 2.8 |
| B-6 | 2 | 101 | 0.28 | 2.3 |
| C-8 | 3 | 105 | 0.30 | 3.3 |
| D-9 | 4 | 63 | 0.54 | 3.2 |

Table 4 - Compressibility Data

| Sample | Water Content % | Initial Void Ratio $e_o$ | Compression Index, $C_c$ | $C_c/1+e_o$ |
|---|---|---|---|---|
| A-5 | 106.6 | 2.93 | 0.72 | 0.18 |
| B-6 | 108.1 | 2.91 | 0.78 | 0.20 |
| C-8 | 96.9 | 2.61 | 0.66 | 0.18 |
| D-9 | 97.5 | 2.66 | 0.63 | 0.17 |

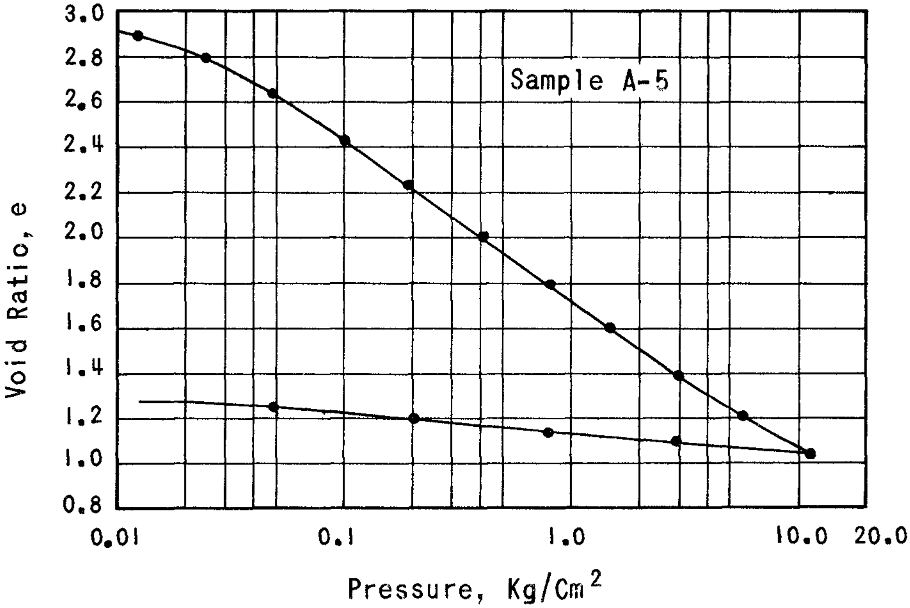


FIG. 7 RESULTS OF CONSOLIDATION TEST

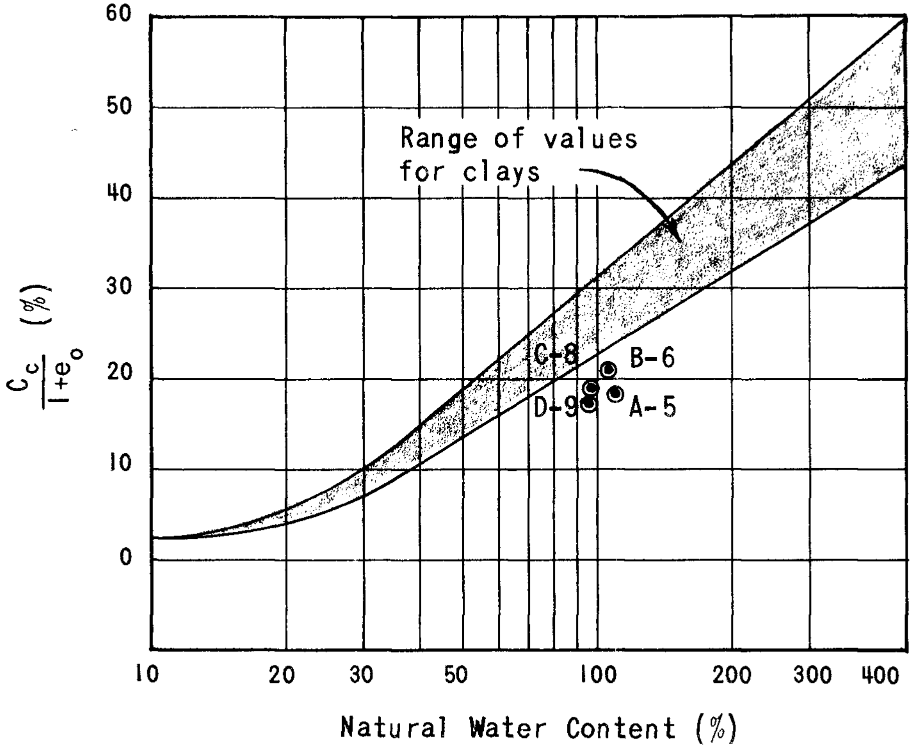


FIG. 8 WATER CONTENT vs. $C_c/1+e_o$

Summary

The engineering properties of near surface sediments obtained by the RUM from four locations on the floor of the La Jolla Canyon in waters ranging in depth from 1256 to 1334 feet were determined. The samples, which were clayey silts of high plasticity, had water contents higher than their liquid limits, had very low strengths (less than 0.5 psi) and medium sensitivities. The samples were highly compressible, but their virgin compression behavior, as evidenced by the $C_c/1+e_o$ values, were somewhat lower but not very different from those of other known marine cohesive soils (4,5).

Acknowledgment

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