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A one-well device for dynamic soil testing

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ABSTRACT: The one-well harmonic device is designed for obtaining in-situ dynamic shear properties of soils under severe seismic actions. This device has been design for avoiding difficulties encountered in seismic reconnaissance, due to the impossibility of testing the soil behind the casing at high strain levels. The prototype is under experimentation in a test area in 200mm diameter holes. A special casing can provide a lateral expansion and alternative vertical movement. An excitation probe is used to apply the special casing to the soil and make it vibrate vertically. Accelerometers, pressure gauges and thermal gauges are forced into the soil behind the special casing from the surface for shallow depths. For greater depths, they are placed from inside the well by robots drilling the casing and forcing gauges into the soil. Surface apparatus provides 12 Kw power, monitors robots and records the measurements.

1 OBJECTIVES

The one-well harmonic device presented here has been designed in order to record in situ dynamic shear properties of a soil under severe seismic actions. This device has been proposed to avoid the difficulties encountered in seismic reconnaissance, which are mainly due to the impossibility of testing the soil behind the casing at high deformation levels. The one-well harmonic device has been designed for reconnaissance wells of around 6" in diameter. The principal equipment is described below.

2 TEST SITE (Figure 1)

An alluvial site was chosen for the tests. A 8m-thick silty layer covers a detritic formation of limestone boulders mixed with clay, with marl substratum at a depth of 12m.

A 2mx3m concrete slab receives all the apparatus necessary for the 6 possible well heads. At the moment, two wells 200 mm in diameter have been drilled; one is 6m deep and the other 12m deep.

Undisturbed samples have been taken for soil identification tests and complementary laboratory tests on the dynamic triaxial apparatus and the resonant column.

Several 76mm diameter holes installed around the test area are essentially used for classical cross-hole tests.

These preliminary tests exhibit values of

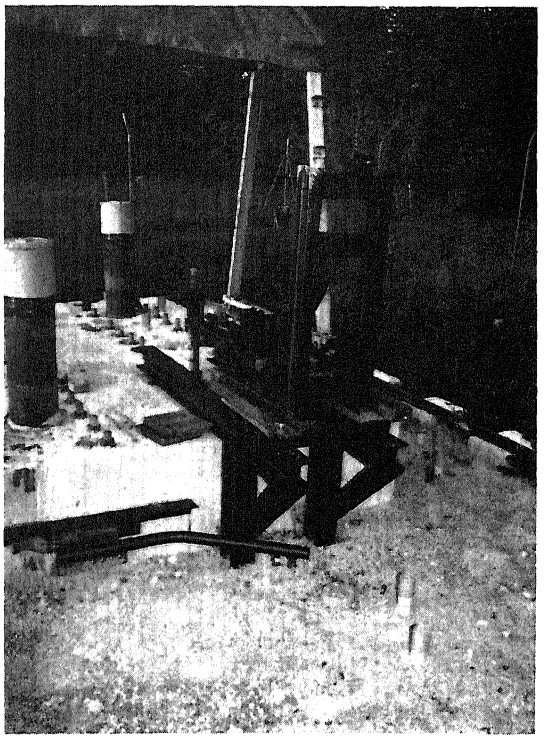

Figure 1 Test slab and well heads

the equivalent elastic modulus of 10 Mpa near the surface up to 1000MPa at a depth of 8m.

During drilling of the two main holes, Measurement While Drilling registration was performed by the Impasol procedure. It shows a high correlation with the cross-hole tests, indicating a soft homogeneous material down to 8 m and then very heterogeneous soil.

3 SPECIAL CASING (Figure 2)

The reconnaissance holes are protected by a standard casing with 160mm inside diameter. However, at each level where measurements are to be made, a special casing is placed between two standard casing sections.

The special casing is a passive part of the device:

- It makes it possible to transmit to the soil a lateral expansion, of a maximum value of 2 cm, with a pressure which can be monitored to balance the initial horizontal stress in the soil.
- It then makes it possible to transmit to the soil an alternative vertical movement, creating shear vertical deformations around the well.

Special casing sections are 1m long and consist of a standard pipe with longitudinal holes to push external mobile pieces against the soil. These mobile pieces possess external notches to prevent sliding between the excitation device and the soil. A special rubber membrane allows all the mobile parts of the system to return to the initial retracted position along the pipe and to an average vertical position.

At the moment, one special casing section is installed at a depth of 1.70m in well No.1. A second special casing section is placed at 6m deep in well No.2.

4 EXCITATION PROBE (Figure 3)

An harmonic probe can move the mobile pieces of the passive special casing section. This probe can be described as follows:

- A central bar, with possibly additional masses, is the inertial piece of the whole system.
- A vertical movement of this mass is possible, under the action of hydraulic vertical jacks and rubber springs.
- Through a system of lateral jacks, this system can be clamped to the standard casing.
- A connecting piece allows the moving mass to be connected with the moving pieces of the special casing.
- Maximum 12 Kw power is delivered to the jacks by an hydraulic circuit with capacity of 200 bars.
- The alternative movement is created by an electrovalve which performs various functions.

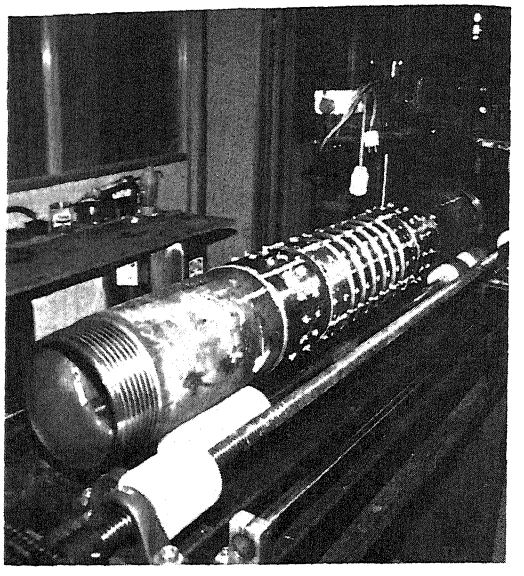

Fig. 2 Special casing

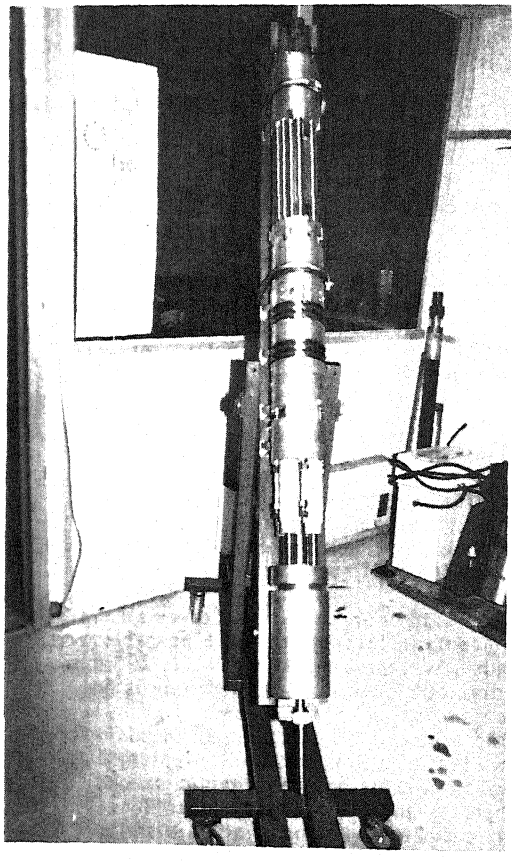

Fig. 3 Excitation probe

5 PLACING GAUGES INTO THE SOIL

5.1 Gauge installation from the surface

At shallow depths, accelerometers or other gauges such as pressure and temperature gauges, are installed in the bottom of small vertical holes, drilled from the surface. Such an installation was realized around preliminary holes 100mm in diameter, situated in the close vicinity of the test concrete slab.

5.2 Gauge installation from the well

At greater depths, placing gauges around the well will be performed by down-the-hole robots.

A first robot drills the casing and small inclined lateral holes into the soil.

Another is designed for placing accelerometers in these inclined lateral holes, with the help of a column of small casing sections. Robots are shown in Figure 4.

6 MEASUREMENT DEVICE (Figure 5)

Gauges and their preamplifiers are placed in a protecting cell which is forced into the soil through the small inclined drillings.

Measures are sent by radio to the main hole and then transmitted to the surface installation.

6 SURFACE INSTALLATIONS

Surface installations provide power and monitor the excitation probe and the down-the-hole robots.

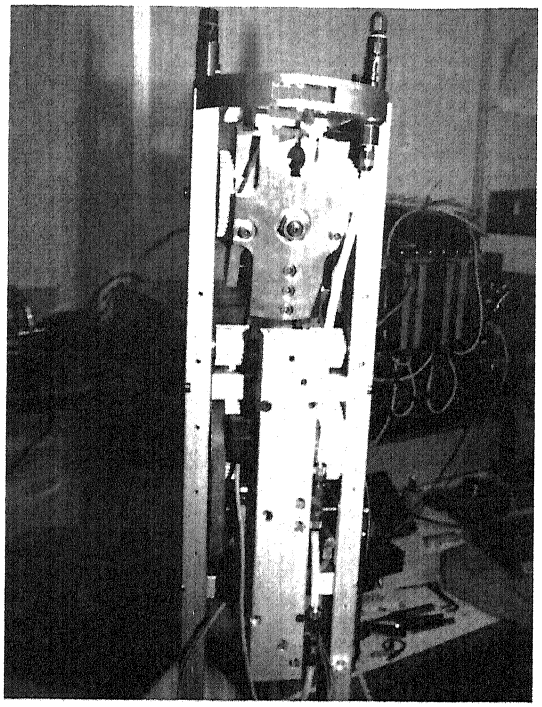

Figure 4 Down-the-hole robots

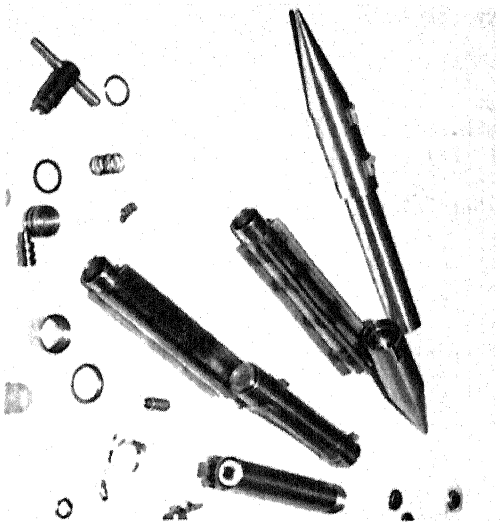

Figure 5 Gauge cell and accessories

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