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FEASIBILITY STUDY ON THE EXPLOITATION OF THE NODULES HIDDEN IN NAUTICAL AND OCEANIC SEA-BEDS BY USING ROLLING LOCOMOTION

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ABSTRACT
Any discovery whatsoever it is requires a mode of displacement to find the need and satisfaction of its desires. Thus, displacement engages several shapes and means to be undertaken. As regards the scientific and technological field, the machines of displacement nowadays are different and varied (it is no use quoting them because the list is exhaustive). Within the framework of the research topic, it is a question of reflecting on the installation an easily suitable machine for the exploration of nautical and oceanic sea-beds of which the ambition is to seek the environmental richnesses hidden in these great depths of which the researchers and the experts strongly need to develop

KEYWORDS: locomotion - great depths - exploration – exploitation - nodules.

I. INTRODUCTION
The research and utilization of building materials occupy a place of honour for the researchers interested by the question. However, local materials and imported materials exist today. This piece of research is directed towards the first up-cited name. In taking into account the nautical or oceanic soil as indispensable support the problem of locomotion and research is more particularly about the exploitation of the nautical and oceanic depths.

However, the current working conditions in the depths have a great influence on the output of the operations engaged because of the more or less hostile environment, on the one hand and of the mechanical behavior of the intended machines doomed to be driven, on the other hand.

Thus, the application of the relative theories to the locomotion in terrestrial environment can exactly be done in nautical and oceanic environment, only with related adaptations; the innovation of this problem calls upon still limited knowledge of the related surroundings and the delicate conditions of accessibility of the oceanic and nautical environments.

- to simulate the medium of deep sea-beds,
- to design the process of propulsion and select the element of rolling,
- to observe the behaviour of the experimental construction.

Attempts of access and exploration are however undertaken in the great sea-beds by researchers nowadays. Certain solutions answering certain needs and requirements do not cease appearing according to the diversity and of the importance of the great sea-beds whose lust does not cease visiting the researchers' spirits regarded by the local materials.

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The ambition to undertake and devotion to the scientific and technological research are the reasons which have opened the door to the discovery and to the expansion of several fields of overall research.

Thus, great nautical and oceanic sea-beds, constitute huge and considerable fields of storage and accumulation of natural exploitable resources. The whole of these resources laid down in the great sea-beds is designated by the term "sedimentary nodules".

Because of the presence of the met metal elements these nodules exist however in several categories according to the original conditions of installation or of the setting up or of their history... As well as for the utilization needs, the researchers and users find themselves in front of an obvious selection of the related products. As to the processing reserved to the nodules, the type or quality will depend on their user.

But nowadays, the essential concern of the researchers is based on the exploitation of the polymetallic nodules. Except the inert nodules, one also finds in the great sea-beds the presence of fauna and flora elements.

However, the discovery and the exploitation of the great sea-beds require the availability of access and the obvious attending in these environments.

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II. EXPERIMENTAL PROCEDURE

Materials

To carry out the study of the locomotion, the set up experimental prototype, comprised the following elements:

- The wheel: it is represented by a polyvinyl cylinder of white color having an external smooth surface; this wheel has a length of 18 cm and a diameter of 8 cm; its specific weight is 1320 g, but this weight turns into 407, 80 g when the wheel is plunged into water because of the principle of ARCHIMEDE.

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This cylinder is assembled on ball bearings in order to reduce the friction effects during the rotation of the wheel around its axis as shown down below.

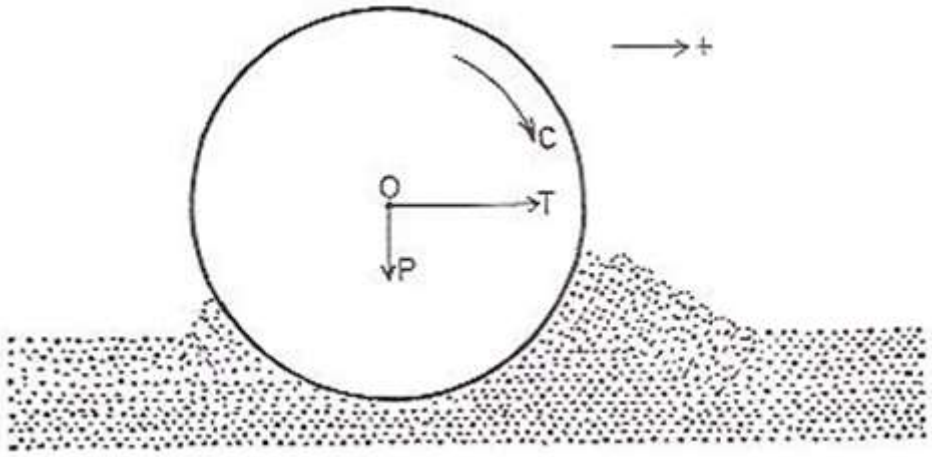

Figure n°1: Tractive motive wheel

-The system of cylinder traction: With a length of 148 cm, 30 cm of width and 25 cm of height, the basic prototype is connected to a vat containing non-cohesive sand. On the vat higher face are superimposed two parallel aluminum guidance rulers of 100 X 10 X 1, 8 cm which are used as rails for the carriage to which the wheel is hung. The following scheme tells more.

-Training carriage : It is the essential element which establishes the connection between the traction engine which is a movement generator, on the one hand and the bearing cylinder, on the other hand which obeys the way of displacement imposed upon by the engine. This element which is essential to the study is composed of welded steel parts whose diagram is as follows

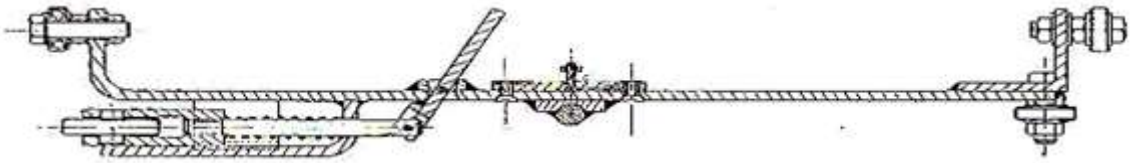

Figure n°2 : Wheel training carriage

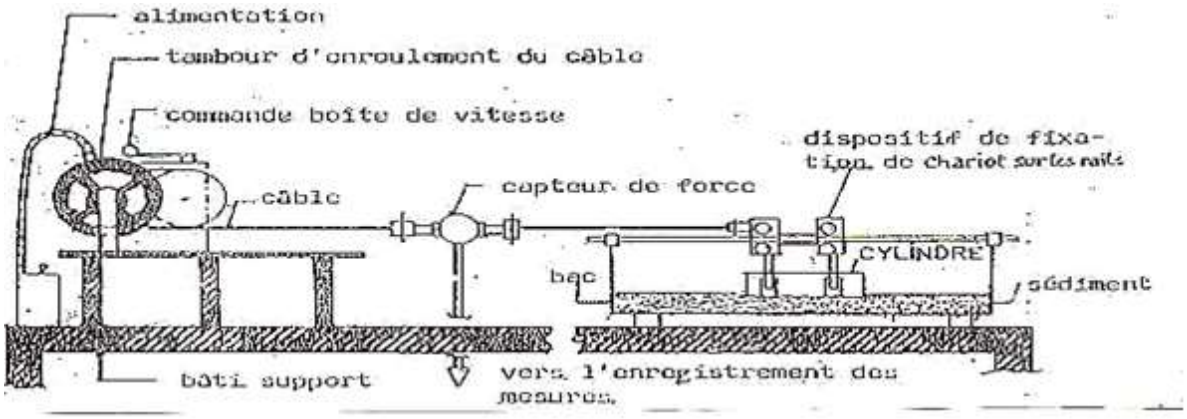

Figure n°3: View plan of the locomotion mechanism Ref.12

The carriage rests on the rails using ball bearings of SKF 608 type being 2, 2 cm of diameter and 0,8 cm of thickness.

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-Traction engine : The engine having been used for handlings is that of the shearing apparatus from **Casagrande of Wykeham Farrance** type.

Speeds of tractions for the results obtained depend on the engine features down below indicated and that are gathered in the table hereafter according to the type of pinion couple

Table nº 1: Shearing speeds of the Casagrande's apparatus

Pinion couple	45/45	60/30	30/60	54/36	36/54
A	0,6096	1,2192	0,3048	0,9144	0,4064
B	0,12192	0,24384	0,060960	0,18288	0,08128
C	0,024384	0,048768	0,012192	0,036576	0,016256
D	0,00048768	0,0024384	0,0024384	0,0073152	0,0032512
E	0,0009753	0,000487	0,000487	0,00146530	0,0006502
	Speeds supply in mm/mn				

For the needs of the study, our choice has been brought to the couple of 60 / 30 pinions on the positions A and E.

This sensor is used for evaluating the intensity of the tractive strain or compression, and even the simultaneous tractive strain and compression. The operation of the force sensor is closely dependent to a conditioner of CA 9046 type manufactured by SCHLUMBERGER.

III. METHODOLOGY

The access to the great nautical and oceanic sea-beds depends deeply on the mastery and the environmental biodiversity. This appealed then to a type of special equipment adapted to this type of environment. However, are recognized three types of movements according to the shape of mobility called "locomotion»; one can quote:

- Locomotion by bearing using a wheel,
- Locomotion by caterpillars,
- Locomotion by defects of ARCHIMEDES.

Among these various types of locomotion, the simplest and cheapest is the locomotion by wheel; it is also the most adapted for our study. The other types of locomotion are stronger and more complex, for they are mostly used probably for military operations.

The first research tasks about the great sea-beds have been undertaken by two noted American schools at the beginning of 20th century and which are as follows:

- LAND LOCOMOTION LABORATORY (L.L.L.) managed by BEKKER, located in DETROIT,
- WATER EXPERIMENT STATION (W.E.S.) of the American Army, located in VICKSBURG.

IV. RESULTS

The plotting table which has been used for the recording of the signal representing the intensity of the tractive strain is of BRYANS XY TO RECORDER type 2600 A3 SIEMENS.

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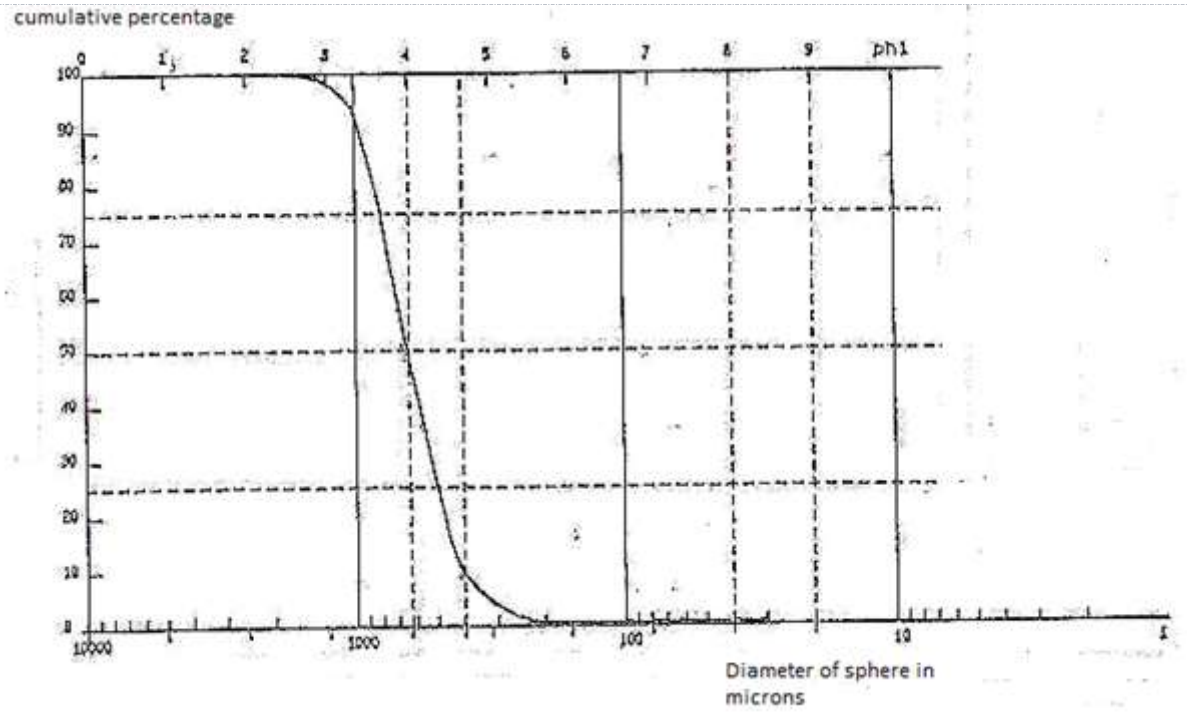

Figure n° 4: Granulometric analysis of the studied sediment

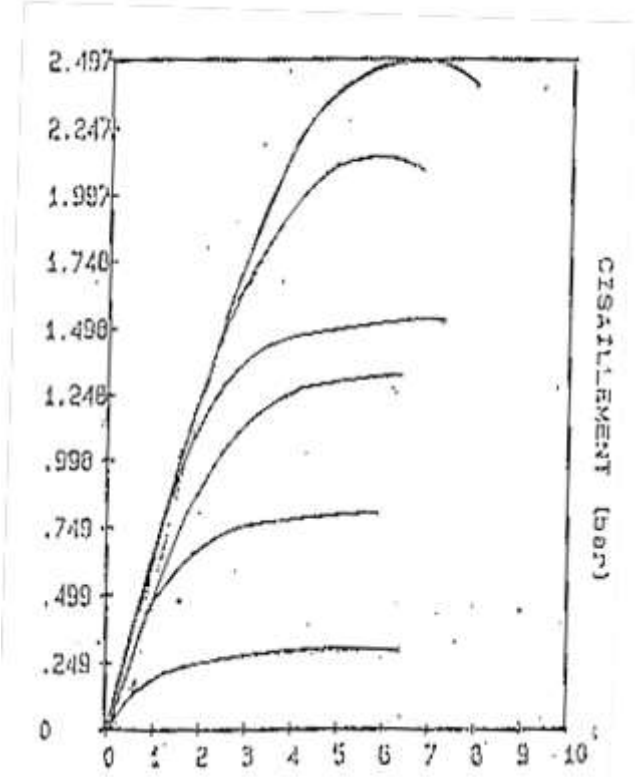

Figure n°5 Results of testing shearing

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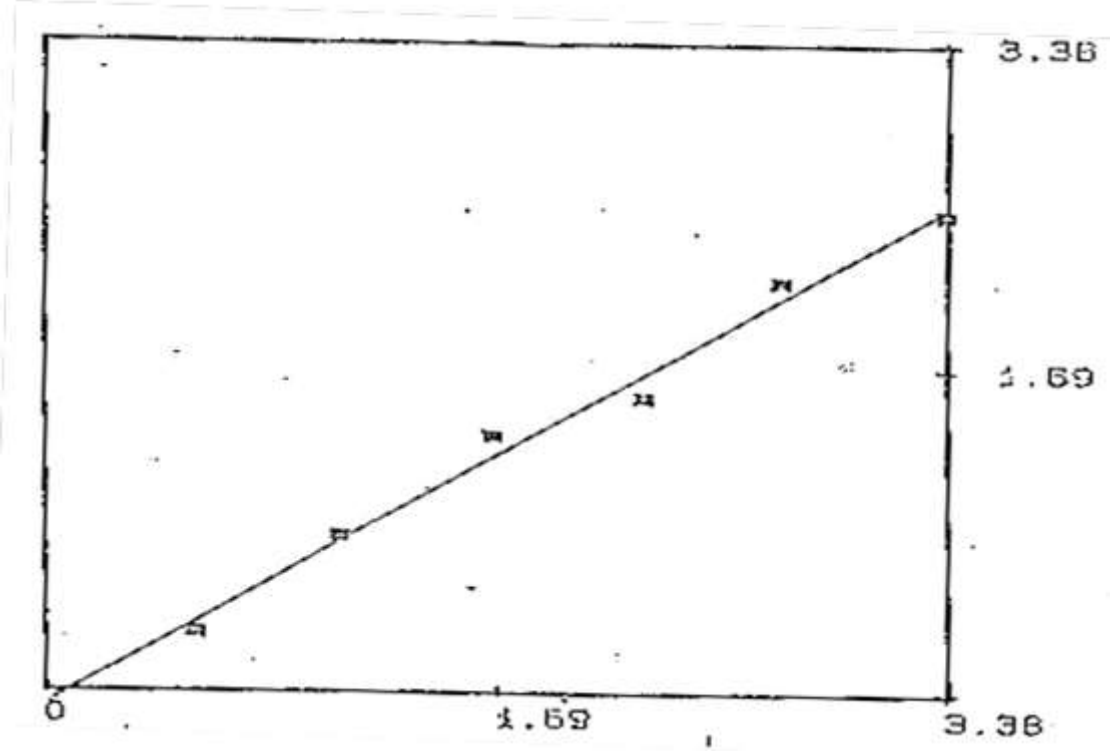

Figure n°6: Assessment of the internal friction angle and cohesion

V. RESULTS AND DISCUSSION

The presented results related to this study consist of the observation of some curves of tractive strain according to the wheel distance of locomotion on the free surface of sand. On these curves the observations showed a mathematical speed pace of the shape "ax + B" whose amplitude varies according to the applied load the wheel in rotation.

It is up to the researchers to set up the suitable arsenals so that the use of the nodules is within the reach of the users interested by these nodules.

The shear test was carried out on fine sand of average particle size.

It was collected at the surface at a depth of less than 15 cm on the Mediterranean coast at BANYULS in France at Eastern Pyrenees.

The dry density of these sediments is approximately about 2.65 with a density of 1.45 N / mm^3.

We used a CASAGRANDE shear device for the sediment treatment to evaluate the intrinsic characteristics of this sand.

To measure the variations of the shear stress (T) as a function of the deformations (£) on the one hand, and the shear stress (T) as a function of those of the normal stress. The results obtained are shown in figure.

These results show that for low shear stresses, the curves presents a horizontal asymptotic appearance and do not exhibit a perfect break.

For high shear stress values, shear curves evolve to achieve maximum breaking strengths.

Figure n ° 7 shows the variations of the maxima as a function of the normal forces, the curve obtained is practically linear, which allows us to obtain the angle of internal friction of the estimated material around 36 to 37 degrees. The estimation of cohesion using CASAGRANDE machine is very low and evaluated at 0.031 N / mm^2.

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The figures below were obtained by the traction force of the wheel as a function of the rolling distance for a speed set in advance.

The first curves are read from right to left according to the recording pattern of the plotter. The first two curves are almost growing and stackable. The local presence of peaks and troughs marks the formation or destruction of a group of sediments mobilized against the free movement of the wheel. It creates a small mound (sediment) in front of the wheel and this accumulation of sediment is called bead and this is visible for testing at low speeds.

As for the last two, the oscillations have the same pace but the amplitudes of the normal regime are almost linear and this linearization continues until the end of the tests. The values of the tensile force remain the same during the duration of the test. This shows no presence of bead during the operation, because sand particles do not have the material time to mobilize and group in front of the wheel because of the high speed of rolling. For all the curves obtained, the traction force of the wheel at the start is always lower than that of the wheel at the finish for a test whose bearing encounters no obstacle.

The last two tests with slightly higher speeds have almost the same pace compared to those that have been done in the open air.

The observation of the handling curves of the prototype makes it possible to release what follows:

a) the first two curves made it possible to be reassured if the circulation of the driving carriage and the wheel leaning on the surface of sand could achieve and harmonize their respective operations;
b) the recording of the signal is made from right towards left, what does not constitute a difficulty of interpretation; and at the end of movement, all the curves are brutally stopped;
c) at the beginning of movement, the strain is intense because of the sinking of the wheel which is subjected to the gravity action , on the one hand and to that of the low density of sand material (1,69) and which is also exposed to the small water current circulating inside the vat in Plexiglas, on the other hand;
d) In the middle of the course of the wheel, the strain amplitudes are generally high in permanent mode and are proportional according to the gradient of various speeds; it is what is observed on the following histogram:

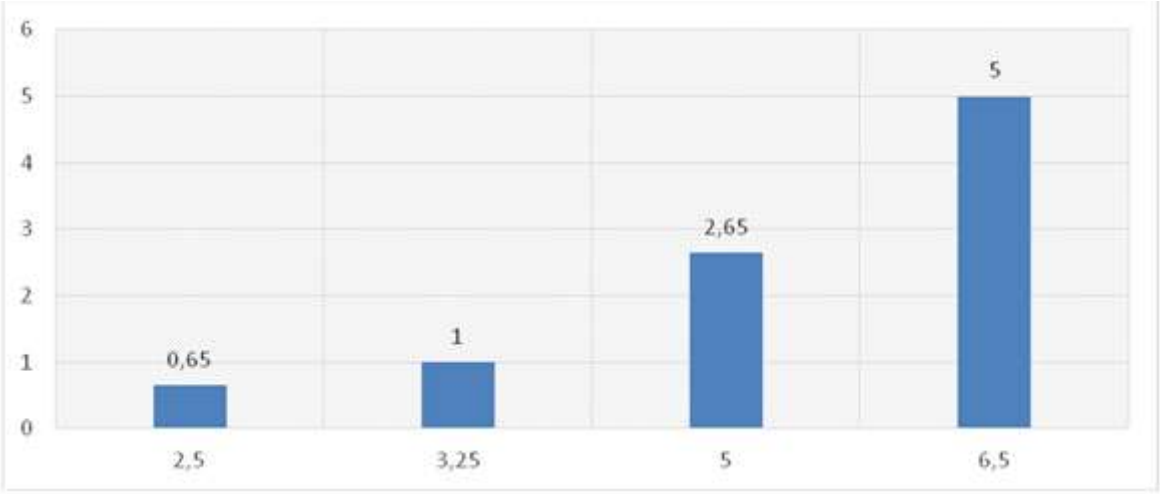

Figure n° 7 : Assessment of the traction strain according to different speeds

VI. CONCLUSION

The locomotion phenomenon is closely related to the ground geotechnical features because of its role of ground-support, on the one hand and the technical capabilities of the manufactured machines to evolve in a certain type of environment, on the other hand. It is only when the working conditions are met that one can have satisfactory results.

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Except the American schools of Land Locomotion Laboratory and Watersways Experiment Station, the teams of researchers like Sterenberg and Auriault of the University of Grenoble, in France have undertaken their first experiment of locomotion by the development of the Instantaneous Center of Rotation related to a free and tractor-drawn wheel. The results obtained by the various schools aroused discussions neither major nor contradictory. However, the obtained curves at the time of the study results almost fit the same speed whose amplitudes vary with the speed of rotation and traction. Although the outcomes of experimental construction of the study, the obtained curves do not require any great satisfaction because of the mechanical complexity of the installation of which the troubles are not excluded. Thus it is desirable that research on topics relating to the exploitation of the nautical and oceanic deep sea-beds keeps on.

Moreover, although symbolic, the objectives laid down by the study have been reached through the obtainment of curves and their interpretations

VII. REFERENCES

[1] Aste, J., P. (1967). Contribution à la locomotion tous terrains sur chenilles. Thèse de Doctorat de spécialités – Université de Grenoble.
[2] Auriault, J., L. (1965). Etude des milieux pulvérulents non chargés dans l'hypothèse de plasticité parfaite. Application au problème d'une roue rigide reposant sur sable. Thèse de Doctorat de spécialité – Université de Grenoble.
[3] Barriol, R., Longuemard J.P., Bilembi D. et Mabiala-Mabele A. J. R. (1985). Traficabilité des objets dans les grands fonds. Rapport semestriel d'activités final du contrat. Université de Perpignan.
[4] Barriol, R., Longuemard J., P. et Bilembi D. (1987). Traficabilité relative des câbles sous-marins /sédiments sous l'action des conditions hydrodynamiques. Rapport semestriel d'activités. Ecole Centrale des Arts et Manufactures de Paris.
[5] Barriol R., Longuemard J., P et Bilembi D. (1988). Mobilité relative aux câbles sous-marins / sédiments sous l'action des houles et des courants. Rapport final d'activités. Ecole Centrale des Arts et Manufactures de Paris.
[6] Barusseau J., P. (1980). Technique d'étude des sédiments. Publication au Centre de Recherche de Sédimentologie Marine. Université de Perpignan.
[7] Bekker M., G et Janosi Z. (1960). 'Analysis of towed pneumatic tires moving on soft ground. Land Locomotion Laboratory – Report N° RR – 6.10.
[8] Bekker M., G. (1964). 'Mechanics of Off-the-road Locomotion. General Motors Corporation' - Defense Research Laboratory. TM 62 – 211.
[9] Biarez, J. (1962). Contribution à l'étude des propriétés mécaniques des sols et des matériaux pulvérulents. Thèse de Doctorat ès sciences, Université de Grenoble.
[10] Biarez, J. (1977). Mécanique des sols en mer profonde. Connaissance de sédiments et technique de reconnaissance de traficabilité. Rapport du Centre Nationale pour l'exploitation des Océans (C.N.E.X.O) – Brest.
[11] Bishop, A and Blight, W. (1976). 'Some Aspects of Effective Stress in Saturated and Partly Saturated Soils'. Annales Géotechniques.
[12] Bilembi D.Etude de la locomotion par roulement: caractéristiques du bourrelet engendrées par l'accumulation des sédiments devant une roue en translation horizontale.thèse de doctorat unique, université de perpignan, 1988

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