PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE ON SOIL MECHANICS AND FOUNDATION ENGINEERING

ROTTERDAM - JUNE 21 TO 30, 1948

Prof. Ir. A. S. Keverling Buisman

2 Nov. 1890 - 20 Febr. 1944

Prof.Ir. A.S. Keverling Buisman
2 Nov. 1890 - 20 Febr. 1944

Engineering circles in the Netherlands learned with satisfaction of the decision, taken in 1936 at the First Internationaal Conference on Soil Mechanics at Cambridge, to hold the Second Conference in the Netherlands. At the time of meeting of the First Conference a general interest manifested itself in the Netherlands for soil mechanics. At the Technical University of Delft the Laboratory of Soil Mechanics, some years previously established, was in full development and already numerous practical problems came in from the field for consideration and advice. The foundation and the development of this laboratory are due in the first instance to the initiative and the devoted work of the late Prof.Ir. A.S. Keverling Buisman.

Those who have followed the pioneer work of Buisman with the greatest of appreciation, feel it their sad duty to commemorate his career and his merits on the occasion of this conference.

After having obtained his degree of civil engineer in 1912, Buisman entered the service of the Hollandsche Beton Maatschappij, where he found an extensive sphere of action both in this country and in the Netherlands East Indies. Already during this period his name became known by the publication of some papers, mainly on the subject of Applied Mechanics and in 1919 he was appointed professor of this subject in the Civil Engineering Department of the Technical University of Delft.

In his inaugural address "The science of applied mechanics and economical design" Buisman showed himself to be an engineer with a broad and practical vision. He qualified Applied Mechanics as the civil engineering science par excellence, stressing the part played by this science in the development of the constructive feeling of the civil engineer. For it does not suffice to calculate a once chosen construction in an economical manner. In the first place the general concept and the fundamental shape must be as favourable as possible. To achieve this, more than just knowledge and the application of formulas is required.

On their local, often water logged soils of poor bearing capacity the Dutch have succesfully achieved the solution of problems of earth-works, foundations etc., the costs of which often constitute a considerable part of the total construction costs. More often here than elsewhere it is seen that the vast difference in soil conditions under structures that must fulfil similar requirements, may lead to totally different concepts, dependent on the locality where they are situated.

Is it any wonder that Buisman, true to this principles to further economical construction, understood that a more scientific investigation on the problems in the sphere of soil mechanics was urgently required?

The occasion that caused this study to be taken in hand effectively came when some failures of earth constructions occurred with serious consequences. The railway accident at Weesp in 1918 as a result of the failure of the embankment at the approach of the railway bridge over the Merwede Canal and the bursting of the dikes of the Zuiderzee in 1916, causing extensive flooding, lead in 1920 to the installation of a committee of inquiry into foundation soils, in which Buisman sat as a member. From now onward Buisman directed his efforts more and more towards the study of soil mechanics, efforts that were destined to yield such rich harvest for our country.

His practical experience had already convinced him that progress was only possible after a more exact insight had been acquired into the mechanical properties of the soil, the necessary basis on which the theory must be founded. His first preliminary tests in the field and on samples taken in the field were done in a rather primitive way. In later years he used to enjoy memories of hours at home, when, assisted by his family, he performed experiments in order to measure the angles of repose of slopes, shearing resistances etc.

The preparation in the Netherlands of large works each with their typical soil problems, in the solution of which Buisman was given an increasingly active part, soon gave rise to a general feeling that a scientific centre for the study of soil mechanics was indispensable.

The publication of Terzaghi's work in 1925 acted as a stimulant on Buisman to push his studies ahead and to persevere in his efforts for a speedy establishment of a well equipped laboratory. At first financed by Buisman's private means and later on aided by the Delft University Foundation the Laboratory of Soil Mechanics at the Technical University came into being in the years 1930 and 1931 on his initiative and at first under his direction. The need for this laboratory appeared to be such, that the number of inquiries showed a steady increase and soon the funds were augmented to such an extent that a healthy growth came within possible reach. It is the merit of Buisman, that he was the first to understand these possibilities and to promote the indicated development to the best of his capacities, thereby not losing sight of the fact that ultimately the laboratory should be the scientific centre for the Netherlands, where the new science should be vigorously furthered. He himself showed a lasting interest in the scientific section of the laboratory as evidenced by his many publications during that time.

About 1930 Buisman started to develop the cell apparatus, in which it was possible to effect any desired combination of the principal stresses, from neutral to critical.

By means of the "cone apparatus" Buisman tried to determine the shearing resistance of the soil sample by applying a load on the cone and by measuring the resulting depth of penetration into the sample.

Formulas, based on the relating studies of Prandtl for metals, showing the relationship between penetration depth and shearing resistance, were derived by him. For field investigation this apparatus was developed into the apparatus now known as the deepsounding apparatus, by means of which it became possible to estimate the point resistance of piles within fairly narrow limits. Some thousands of deep-soundings have since been made, both in this country and abroad.

Comparative observations, in the field as well as in the laboratory created in Buisman the conviction that the so called layer-thickness-effect for highly compressible soils of low permeability is not so great, at least for soil conditions in the Netherlands, as it would be according to the hydrodynamical consolidation theory of Terzaghi. He explained this by starting from the assumption of a "heterogeneous permeability" i.e. by assuming that the soil mass consists of systems of low permeability arranged alongside of systems with wide pores. On the time needed for the expulsion of moisture from these systems the thickness of the layer would play a less important part than in the case of "homogeneous permeability". Be it noted that the idea of physically adsorbed water was already present to his mind.

Another important contribution was the theory, formulated in cooperation with others, about the flow phenomena of the continuous capillary groundwater which, as demonstrated by experiments, follows the same laws as the "phreatic" water. As far as we know this is the first time that equilibrium computations by means of the so-called Swedish method of assumed curved surfaces of sliding, were performed, taking separately account of positive and negative water pressures.

Lastly, mention should be made of his studies on stress distributions in the soil, especially at earth retaining structures, where he took into account the relative deformations of soil, piles and sheet piling. An example of this is given in the article No. V b 4 adapted by Ir. T.K. Huizinga, Director of the Laboratory of Soil Mechanics at Delft.

In his book "Grondmechanica", published in 1940, Buisman gave an excellent survey of the position of modern soil mechanics.

In 1939 he departed for the Netherlands East Indies to give a course of lectures at the Technical University of Bandoeng. Prevented from returning by the occupation of the Netherlands by Germany, he made a virtue of necessity and prosecuted his studies vigorously. A new edition of his text-book, enlarged with typical local problems, was published there.

During the Japanese occupation of the Netherlands East Indies Buisman was interned in 1943. We were not to have the privilege of seeing him again: in the camp he contracted an illness, from which he did not recover and an active life, which still showed much promise, was broken off.

To his friends, colleagues and collaborators who had looked forward to renewed cooperation with Buisman, the consolation is given to remember that the work still proceeds in his spirit.

G.H. van Mourik Broekman.

PROCEEDINGS OF THE SECOND INTERNATIONAL CONFERENCE

ON

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ROTTERDAM
JUNE 21 TO 30 - 1948

VOLUME I

PREFACE OF THE COMMITTEE ON ORGANISATION

When the exceptional success of the First International Conference on Soil Mechanics and Foundation Engineering had prompted the desire to hold similar Conferences at regular intervals, it was not long before the idea to hold the Second Conference in the Netherlands had received consideration. However, the Second World War prevented any such intention from materializing at the time originally foreseen.

Now that the moment has arrived to prosecute the once abandoned plane, the Netherlands Government and the Municipality of Rotterdam have invited the Permanent Committee of the International Conference on Soil Mechanics and Foundation Engineering to call the second Conference in the Netherlands. Although this is no longer the prosperous country of years gone by and although few countries emerged from the struggle more damaged and more plundered, it is the pride of government and nation to show how much their energy and resources are harnessed to the reconstruction of the devastation wrought by the war. In this context it is symbolic that Rotterdam, the town that was damaged most, has offered to be the seat of the Conference.

It is with these considerations in mind that the Committee on Organisation has assumed its task with great pleasure. It is glad that the preliminary announcements concerning the Conference have met with a wide response over the whole world, so much so, that the size of this Conference is likely to exceed the expectations which were founded on the experiences gained at Cambridge during the First Conference. It should be clear that this means a heavy strain on the available resources in a country, where three years ago no machines or supplies of any kind, no food nor the simplest daily requirement were to be had.

The Committee therefore invokes the clemency of the members of the Conference, should they not find everything up to the standard they would have expected on a similar occasion in pre-war days.

J.P. van Bruggen, president
T.K. Huizinga, secretary
E.C.W.A. Geuze

PREFACE BY THE EDITORIAL COMMITTEE

On the occasion of the publication of the first two volumes of papers for the Second International Conference on Soil Mechanics and Foundation Engineering, the Editorial Committee feels that a statement would be appreciated on the line taken for the composition of these Proceedings.

The great number of prospective contributions made the Committee's task to ensure timely distribution of the bound and printed copies of the Volumes difficult. On the 2nd of January of this year only 57 papers out of a total number of 480 promised, were received by the Committee. Although part of the preparatory work, especially the classification according to the subjects, had already been undertaken - based on the summaries previously received - the major part, viz. the preparation of the material for the printer, had to await the arrival of the complete papers. The delay in the forwarding of these papers has contributed to make the task of the Committee heavy.

In these circumstances, it has been found necessary to deviate from the initially set principles in two respects, viz:

1° While it has been tried to avoid undue splitting-up of sections and sub-sections over the various volumes, papers have been placed in order of their arrival more often than was foreseen.

2° The definition of the subjects of the various sub-sections had been based on the summaries received. A number of papers however have been submitted of which no previous summary had been sent. Therefore the classification does not necessarily cover all the papers as finally published.

Alterations in the author's text have been limited to the make-up and to obvious errors of typing and spelling.

The Committee apologizes for any errors, which may have occurred in the papers in the process of preparation for printing. It asks members to view these in the light of the difficulties outlined above.

N. Nanninga, President
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E.C.W.A. Geuze
A.W. Koppejan

REVIEW OF SECTIONS AND SUB-SECTIONS

S E C T I O N I: THEORIES, HYPOTHESES, CONSIDERATIONS OF A GENERAL CHARACTER

Sub-sections:

a. general considerations
b. geology and soil mechanics
c. physical and physico-chemical properties of soils
d. stress-strain relations; consolidation
e. shearing strength and equilibrium of soils
f. earth pressure
g. stress distribution
h. vibrations and mathematical problems
i. miscellaneous

S E C T I O N II: LABORATORY INVESTIGATIONS.

Sub-sections:

a. general
b. identification tests
c. consolidation tests
d. triaxial tests
e. direct shear tests
f. electro-osmosis
g. miscellaneous

S E C T I O N III: FIELD INVESTIGATIONS.

Sub-sections:

a. boring and sampling
b. measurements of special soil properties
c. measurements of pressures and deformations
d. vibrational research
e. aerial photographing
f. areal studies
g. miscellaneous

S E C T I O N IV: STABILITY AND DEFORMATIONS OF EARTH CONSTRUCTIONS.

Sub-sections:

a. embankments of highways and railroads
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c. excavations and slopes
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S E C T I O N V: EARTH PRESSURE; STABILITY AND DISPLACEMENTS OF RETAINING CONSTRUCTIONS.

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S E C T I O N VI: FOUNDATION PRESSURE AND SETTLEMENTS OF BUILDINGS ON FOOTINGS AND RAFTS.

Sub-sections:

a. measurements of settlements and comparison with theory
b. measurements of stress distribution in the contact face
c. influence of groundwater
d. special problems in foundation engineering

S E C T I O N VII: PILE FOUNDATIONS, PILE LOADING TESTS.

Sub-sections:

a. settlement and bearing capacity of piles
b. horizontal pressures on pile foundations
c. special problems

S E C T I O N VIII: PROBLEMS OF ROAD AND RUNWAY CONSTRUCTIONS.

Sub-sections:

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b. methods of flexible pavement design
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f. miscellaneous

S E C T I O N IX: IMPROVEMENT OF THE MECHANICAL PROPERTIES OF SOIL.

Sub-sections:

a. general considerations
b. mechanical methods
c. physico-chemical methods
d. physical methods

S E C T I O N X: GROUNDWATER PROBLEMS.

Sub-sections:

a. general groundwater investigations
b. seepage problems of dams and levees

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S E C T I O N XII: SUBJECTS OF A GENERAL CHARACTER.

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a. Classification of Soils
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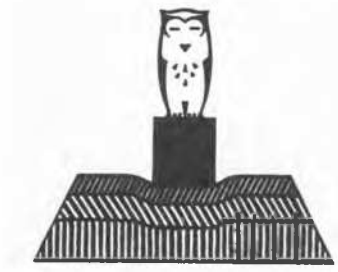

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by the Editorial Committee

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CONTENTS OF VOLUME VI

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A GROUP OF PARTICIPANTS OF THE CONFERENCES AT THE ENTRANCE OF THE CITY THEATRE AT ROTTERDAM

NAMES OF THE PARTICIPANTS ON THE PHOTOGRAPH

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197	Westbroek, P.
116	Quak, J.D.

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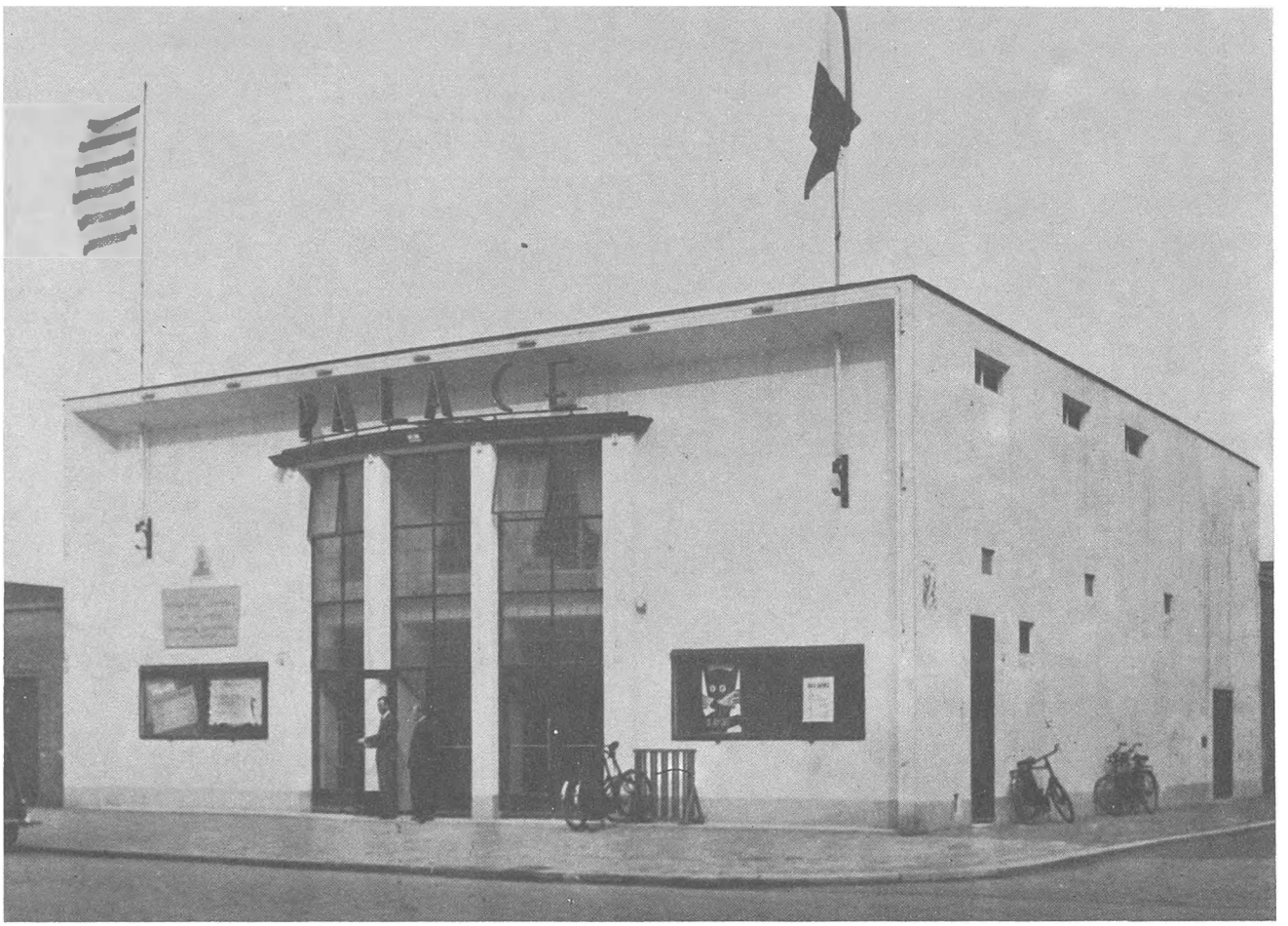

Palace Theatre, the seat of the Conference.

Volume II.

Paper VIc 1 : p.150 2nd col. 11th line from below should read: as given in the table.

Paper VIIIe 1 : p.274 The 4th last line should read: as far down as 7 m....., in stead of: as high as 7 cm.

Paper VIIIe 3 : The text of fig. 3 should read: Apparatus for manotric measuring of the suction-force.

1. measure watch (comparator)
2. cup
3. frozen carbonic acid (-80°C)
4. alcohol
5. insulating disk
6. "eternit" tube
7. sheet brass
8. wire sieve
9. water container
10. glass tube
11. capillar tube
12. vertically movable mecury-filled vessel
13. rubber tube
14. sand layer
15. ground-water level
16. scale
17. soil sample
18. bakelite tube
19. glass wool

Paper Xb 1 : p.322 Notation $Np = \frac{h_e}{h_p}$ should read: $N = \frac{h_c}{h_p}$

p.323 2nd col. 14th and 15 th line: X should read G_s

16th and 24th line: h_c should read h_e

p.324: 1st col. 9th and 27th line: h_c should read h_e.

Volume III.

Paper Id 5 : p.21, 2nd col. 2nd formula: p_f should read b_f.

Paper Id 6 : p.25, table I: e values should read Δ_e values.

Paper Id 8 : p.34, 1st col. 16th and 17th line from below should read: ..... settlement due to p_o. In the case of fig. 4 the settlement .....

2nd col. 19th line from below: s_w should read $s\gamma_w$

Paper Ie 14: p.53 2nd col. 15th line t and ....., should read t and τ

Paper Ig 7 : p.74 The first 5 lines of left column should be placed at the end of the column.

Paper IId 8 : p.128, 2nd col. 3rd line from below: vertical should read horizontal.

Paper IIId 2 : p.216, 2nd col. last line: ν should read $\nu_\wedge$

Paper Va 2 : This paper should include the following acknowledgement: "this paper is published with the approval of the Lords Commissioners of the Admiralty, but the responsibility for any statements of facts or opinions expressed rests solely with the author".

Paper Va 4 : fig. 2, 3. The formula for W_1 should read:

$$W_1 = t(2 - t\alpha_x)\frac{\gamma_1 H^2}{2}$$

Paper Vc 2 : p.316, 2nd col. last formula should read:

$$p_2 = \frac{0.293}{1.707} \times \frac{1}{23.14} p_1$$

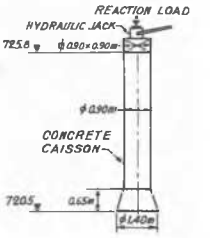

FIG. c

Volume IV.

Paper VId 9 : Fig. c should be added to fig. 5.

Paper Xb 2 : Fig. 6: The scale at the bottom should read: "Total Net Head - H in feet", instead of: " H in inches".

Volume V.

Note by the Ed. Comm.: The numbers Ie 21 and Xa 10 should read: Ie 20 and IVd 4, respectively.

Paper Xb 4 : Fig. 1 Under case I-a-5 the formula for H_1 should read:

$$H_1 = \left\{H' + (1 - H') - \frac{\varphi}{\varepsilon}\right\}H$$

Under case I-b-3 L terms should be L_2.

After * the title should read "Table of Integrals and other Mathematical Data".

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E R R A T A - S H E E T

Volume I. Paper Id 1 : p.33, 2nd. col. 3rd line n_3 should read n_s.

Paper IIe 1 : Fig. 1 has been omitted. See fig. a.
Photo 2 is turned upside down.

Paper IIIb 2 : Equation 2 (Table II) should read:
$= 2.00 - 0.042\ X_1 - 0.0057\ X_3 - 0.0021\ X_4$.

Paper IIIb 7 : p.283, 1st col. 2nd line from below: Title of par.b should read: Piston Sampler.

Paper IIIc 3 : Fig. 6 should be replaced by fig. b.

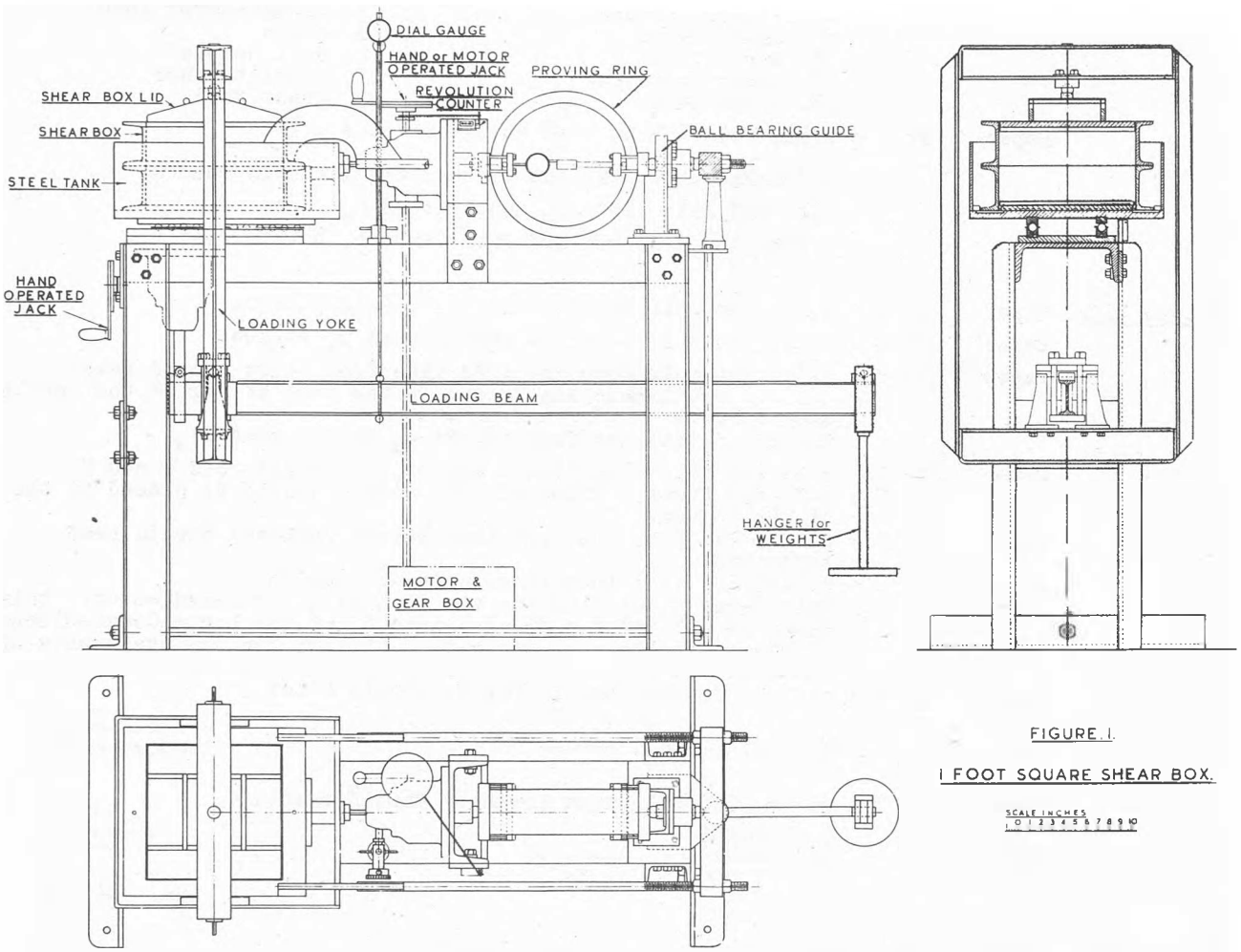

FIGURE I.

I FOOT SQUARE SHEAR BOX.

SCALE INCHES 1 0 1 2 3 4 5 6 7 8 9 10

FIG. a

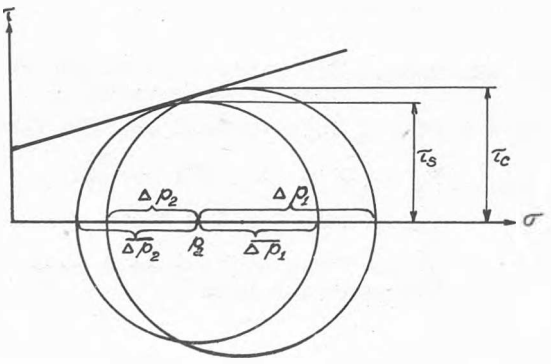

FIG. b