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The New Irrigation Era

1976 - January.

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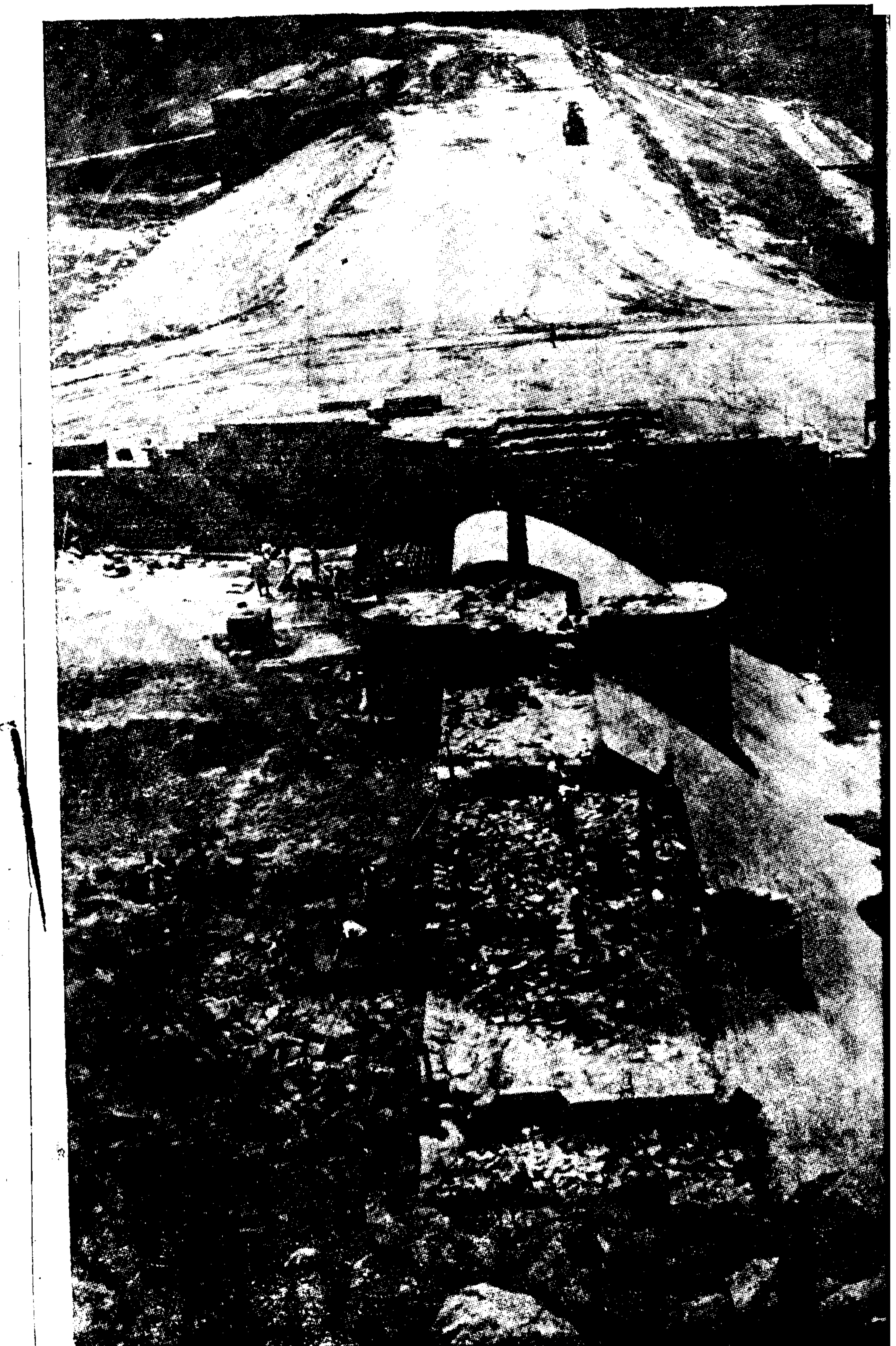
பாசன முறையின் மறுமலர்ச்சி செய்தி

THE NEW IRRIGATION ERA



"சின்னர்" நீர்த்தேக்க திட்டம்.

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தொகுப்பு 14 : இதழ் 1.
சனவரி 1976

Vol. XIV–Issue 1.
January 1976

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PRIME MINISTER'S
Twenty Point Economic Programme

1. Accelerated efforts to bring down prices of essential commodities, increase production, speed up procurement and streamline distribution of essential commodities.
2. Implementation of agricultural land ceilings and quicker distribution of surplus land.
3. House sites for landless and weaker sections.
4. Abolition of bonded labour.
5. Liquidation of rural indebtedness.
6. Revision of minimum wages for agricultural labour and their enhancement, where-ever necessary.
7. Five million more hectares to be brought under irrigation.
8. Further generation of 2,600 megawatts of power.
9. Special help for handloom industry and protection to Weavers.
10. Improvement in quality and supply of cloth for the common man.
11. Socialisation of urban and urbanisable land. Ceiling on ownership and possession of vacant land and on plinth area of new dwelling units.
12. Prevention of tax evasion, summary trials and deterrent punishment to economic offenders.
13. Special legislation for confiscation of smugglers' properties.
14. Liberalization of investment procedures and action against misuse of import licences.
15. New schemes for more effective participation of workers in industries.
16. Removal of constraints on the movement of goods by trucks—National permit system to be introduced.
17. No income-tax up to an annual income for Rs. 8,000.
18. Supply of essential commodities at controlled prices to students in hostels.
19. Provision of text books and stationery for students at controlled prices—also book banks.
20. New apprenticeship schemes to enlarge employment and training, especially of weaker sections.

EDITORIAL

Er. P. Kumarasamy, Director-in-charge, Institute of Hydraulics and Hydrology, Poondi and member of the editorial board of this journal, who has been awarded Nehru Fellowship, is developing a technique for forecasting floods and flows in the Rivers of Tamil Nadu. A hydrological model simulating the topographical feature of the entire peninsular India between the latitude 7° N and 17° N is under construction to a scale of 1/10,000. Over this model, arrangements to simulate rainfall whenever required are also being made. A VHF Telemetry system is being built with which it will be possible to transmit data of instantaneous rainfall occuring anywhere in Tamil Nadu to Poondi and as soon as this data is received it will be simulated on the hydrological model. The consequent runoff in the hydrological model will be electronically measured, and from these data the paramaters for a mathematical model will be completed through the use of an Analog Computer and a Digital Computer. Utilising these paramaters, further prediction will be made and transmitted by the field engineers. After the actual flow values are obtained, again through the Telemetry from the field, the calibration of the hydraulic model will be refined further. By such a step-by-step procedure it is expected to develop a true hydrological model for every basin as well as its accurate mathematical model.

Prediction technique enunciated above depends entirely on base data collection of rainfall particulars, and flow gauge readings. The accuracy of prediction goes hand in hand with accurate and sufficient base data. This could be obtained only by improvising the now existing rainfall stations and discharge Gauging Stations quantitatively as well as qualitatively. By this prediction gate openings of various reservoir can be scientifically decided and diversion of flood flows can be properly done to minimise loss of flood flows. By accurate datas obtained, economical designs of Irrigation structures can be effected. Let us hope that by this research, Tamil Nadu will be far ahead the other States in Irrigation Water Management, in the near future.

EDITOR.

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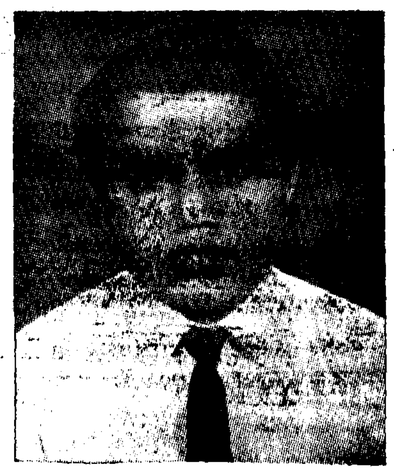

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OUR EDITORIAL BOARD MEMBER GETS NEHRU FELLOWSHIP AWARD

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Celia Kirby.

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RADIO ACTIVE TRACER STUDY FOR SETHUSAMUDRAM SHIP CANAL PROJECT

By

1. THIRU K. RAMALINGAM, BE. AND 2. THIRU A. MOHANAKRISHNAN, BE., M.SC.

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THE PROJECT.

Sethusamudram Ship Canal Project contemplates the creation of a navigable link canal between the Indian Ocean and the Bay of Bengal cutting through the Rameswaram Island in the Gulf of Mannar separating Sri Lanka from India. This Canal will provide a short cut for ocean going vessels which sail round Cape Comerin to reach major ports like Madras, Visakapatnam and Calcutta in the east coast of India without having to touch Colombo.

Proposals to cut a short-cut canal through this Gulf has been there for over a century now. As early as 1860, Commander Taylor came up with a proposal estimated to cost about Rs. 50 lakhs. Since then there were as many as fourteen different proposals put forward by individuals and Committees. The present project proposals now under consideration of the Ministry of Transport and Shipping, Government of India were formulated after detailed investigation from 1965 to 1968 by a Special Engineering cell headed by the late Sri C. V. Venkateswaran, retired Chief Engineer, Cochin Port.

The Ship Canal Project is estimated to cost 3750 lakhs of Rupees and has the following main features :—

(i) An approach channel 2 miles long will be dug for 450 feet bed width and 36 feet depth in the Gulf of Mannar to the south of Rameswaram Island.

(ii) On land across the Rameswaram Island, the canal will have 210 feet. bed width and 36 feet depth and will again be two miles in length.

(iii) To the north of the Island in the Palk Bay the approach channel will be 450 feet in bed width and 36 feet depth and two miles in length.

(iv) Further north in the shallow Palk Bay a wide channel of 750 feetbed width and 38 feet depth will be dug for 23 miles length until the 6 fathom contour in the Bay of Bengal is reached.

(v) A lock 960 feet $\times$ 125 feet clear, with sector gates from -37 feet to $+9{\cdot}0$ feet is porposed in the land canal since there is considerable difference in tidal levels obtaining on the north and south of Rameswaram Island.

This canal is designed to take ships up to 30 feet, draft which can also be modified to take ships a up to 36 feet, draft later when required and would save 300 to 350 miles for the ships sailing from West-Coast to the East-Coast of India.

II. THE PROBLEM:

The main problem that came in for examination before the project could be declared technically feasible was the correct assessment of the possibility of maintaining the 23 miles long Bay of Bengal channel dredged in the open sea.

The sea bed in the channel alignment is fine sand with soft clay in a few places. The total quantity of capital dredging to be done on the Bay of Bengal channel alone is estimated as 35·13 million cubic yards. The dredging has to be done by large capacity hopper dredger capable of dredging in swells of 7 or 8 feet and the dredging spoils dumped in predetermined location safely away.

The following questions arose :—

(i) How far and on what directions should the dumping site for capital dredging be located so that there is no possiblity of the dredged material travelling a back to the deep channel and at the same time involve minimum leads ?

(ii) Which is the significant direction of the bed silt movement in the region of the Bay of Bengal channel ?

(iii) Is the bed silt movement influenced by the ocean currents in the region round the year and the two monsoons and if so to what extent ?

(iv) Will the littoral drift of sand seen along the east-coast of India fill up this dredged channel and eventually make maintenance an uneconomic problem ?

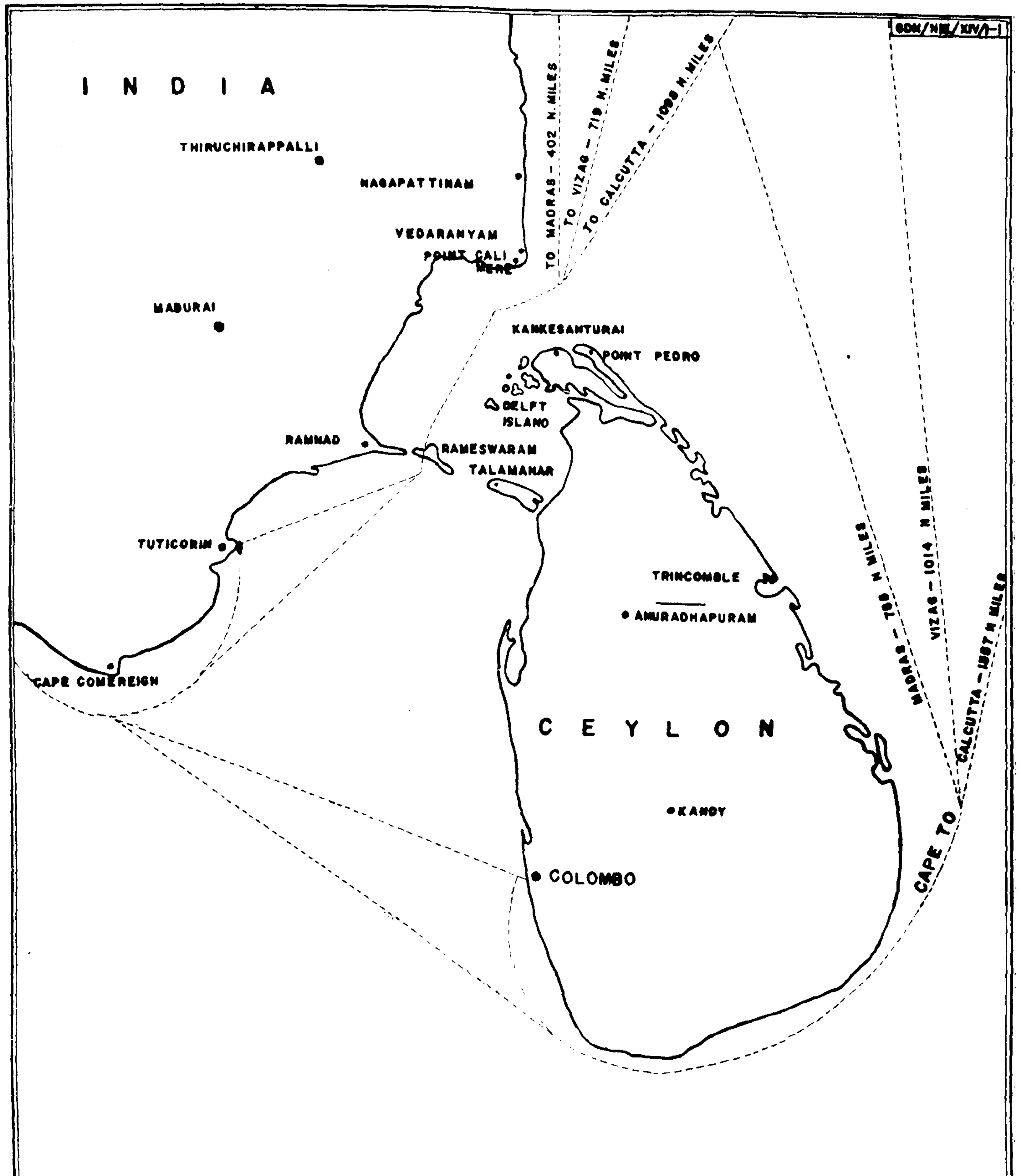
III. FIELD STUDIES:

Among the various items investigated in the field, collections of sub-soil date borings, studies, on waves, wind and current and silt charge and littoral drift observations are relevant to the questions raised and provided data from which certain conclusions could be drawn.

But, ultimately it is the adoption of the technique of Radio Active Tracer Studies that give a comprehensive answer to these questions.

The Bhabha Atomic Research Centre, Trombay, the Hydrograph Survey Wing of the Ministry of Transport and the Central Water and Power Research Station, Khadakvasla, were associated in carrying out this study in the open sea far from the land stations.

1. Superintending Engineer, P.W.D.
2 Senior Deputy ChiefEngineer, P.W.D. (Irrigation), Madras-5.



SETHUSAMUDRAM PROJECT

INDEX PLAN

SCALE: $\frac{1}{2534400}$

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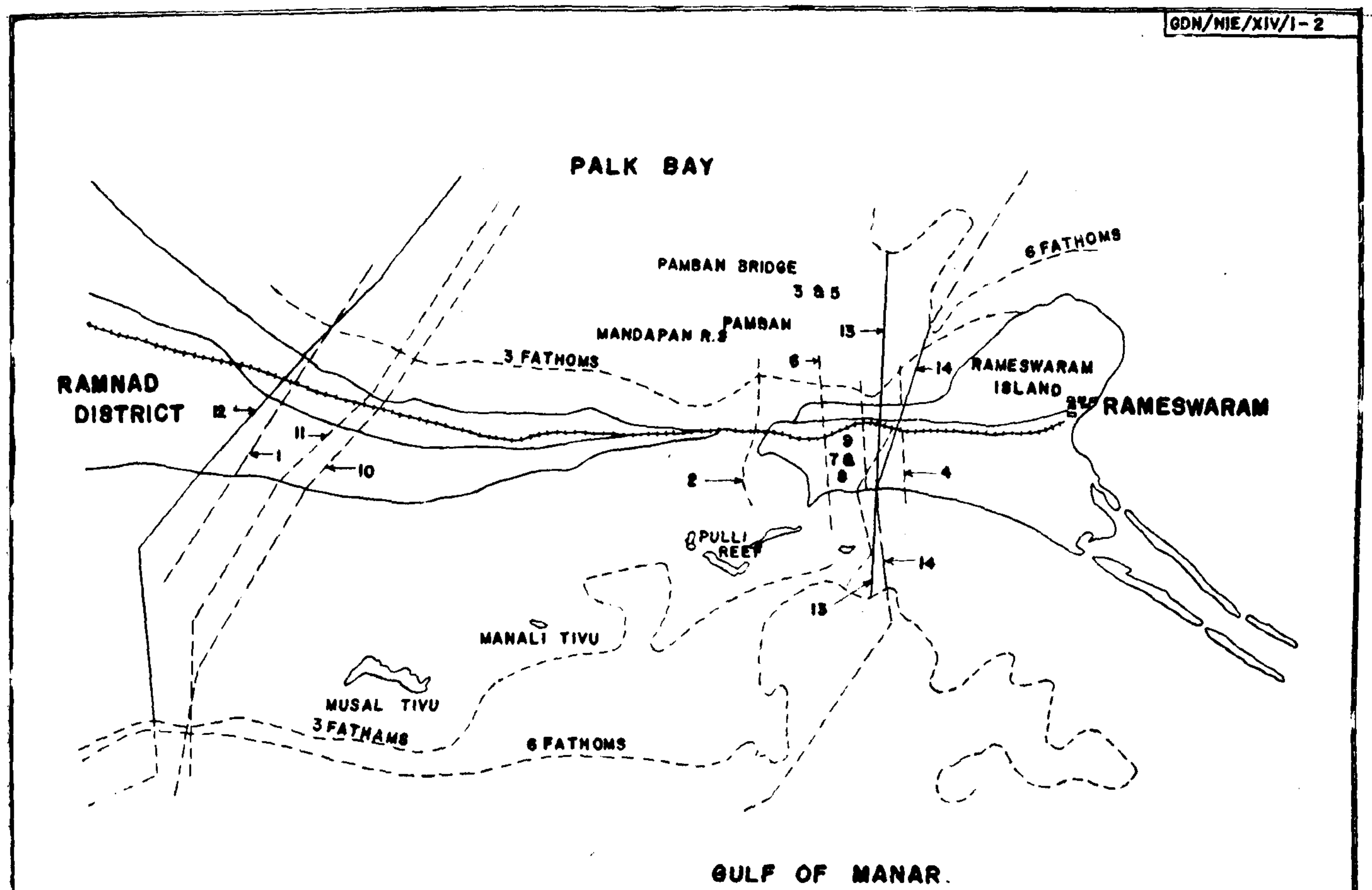

NO.	YEAR	ALIGNMENT PROPOSED BY
1	1960	COMMANDER TAILOR OF THE INDIAN MARINE
2	1861	MR. TOWNSHEND
3	1862	PARLIAMENTARY COMMITTEE
4	1863	HE. SIR WILLIAM DENISON (GOVERNOR OF MADRAS)
5	1871	MR. STOPPART (SAME AS NO. 3)
6	1872	MR. ROBERTSON. HARBOUR ENGINEER OF INDIA
7	1884	SIR JOHN CODE. FOR SOUTH INDIA SHIP CANAL PORT & COALING STATION LTD. U.K.
8	1903	S.I. RAILWAY
9	1922	SIR. ROBERT BRISTOW HARBOUR ENGINEER TO GOVT OF MADRAS
10	1956	SETHUSAMUDRAM PROJECT COMMITTEE (UNDER THE CHAIRMANSHIP OF SIR. A. RAMASWAMY MUDALIAR.)
11.	1960	CAPTAIN DAVIES
12.	1961	MADRAS GOVERNMENT - AS FURTHER MODIFICATION. TO 10 & 11 BASED ON A FRESH HYDROGRAPHIC SURVEY.
13	1966	SHRI. C.V. VENKATESWARAN. CONSULTANT.
14.	1967.	SHRI. C.V. VENKATESWARAN. CONSULTANT AS MODIFICATION TO 13 BASED ON FURTHER WIND AND BORING DATA.

SETHUSAMUDRAM PROJECT.

VARIOUS ALIGNMENTS PROPOSED

SCALE: $\frac{1}{17600}$

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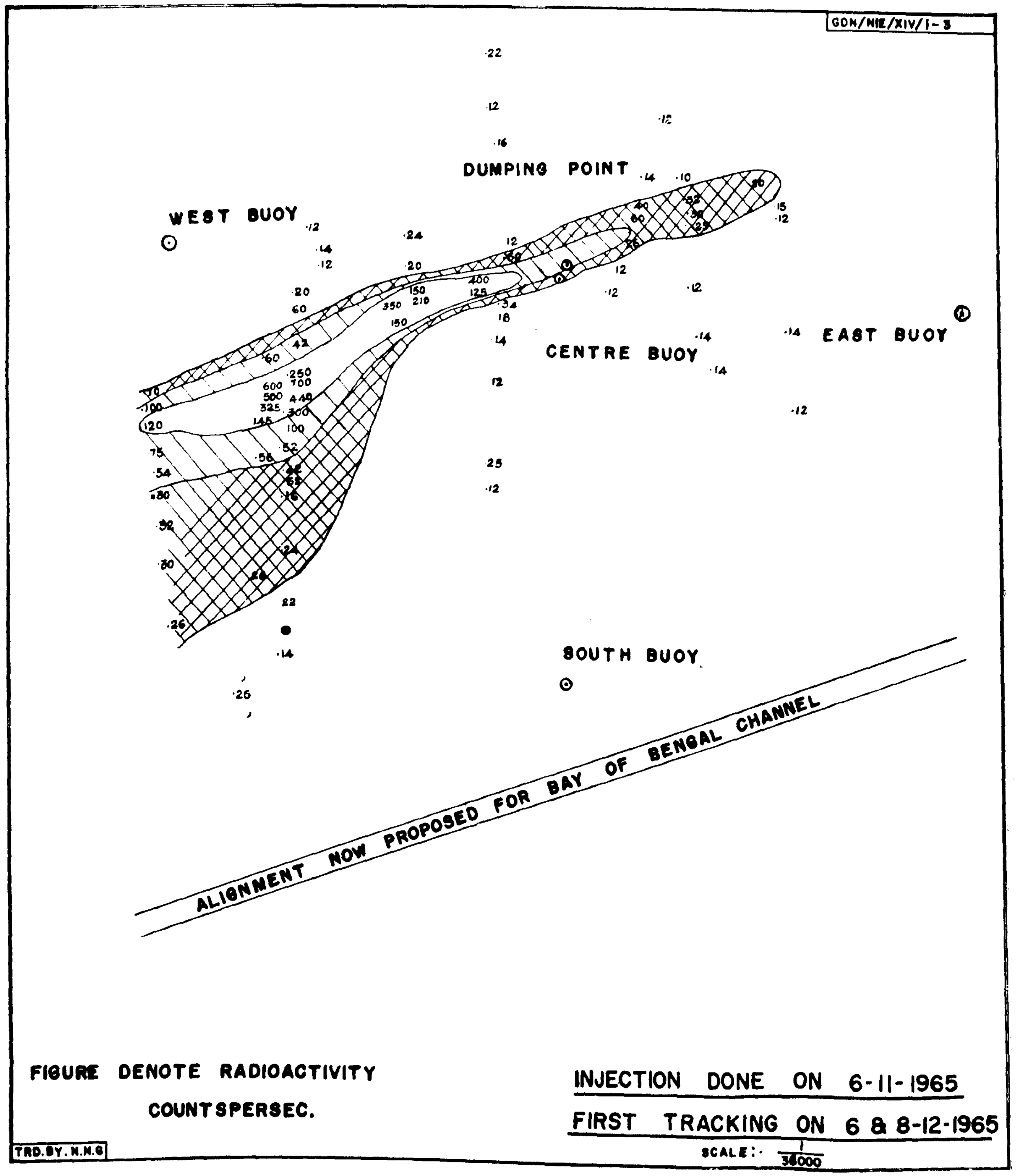
GDN/NIE/XIV/I-3
DUMPING POINT
WEST BUOY
CENTRE BUOY
EAST BUOY
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR BAY OF BENGAL CHANNEL
FIGURE DENOTE RADIOACTIVITY
COUNTSPERSEC.
INJECTION DONE ON 6-11-1965
FIRST TRACKING ON 6 & 8-12-1965
SCALE:- 1/36000
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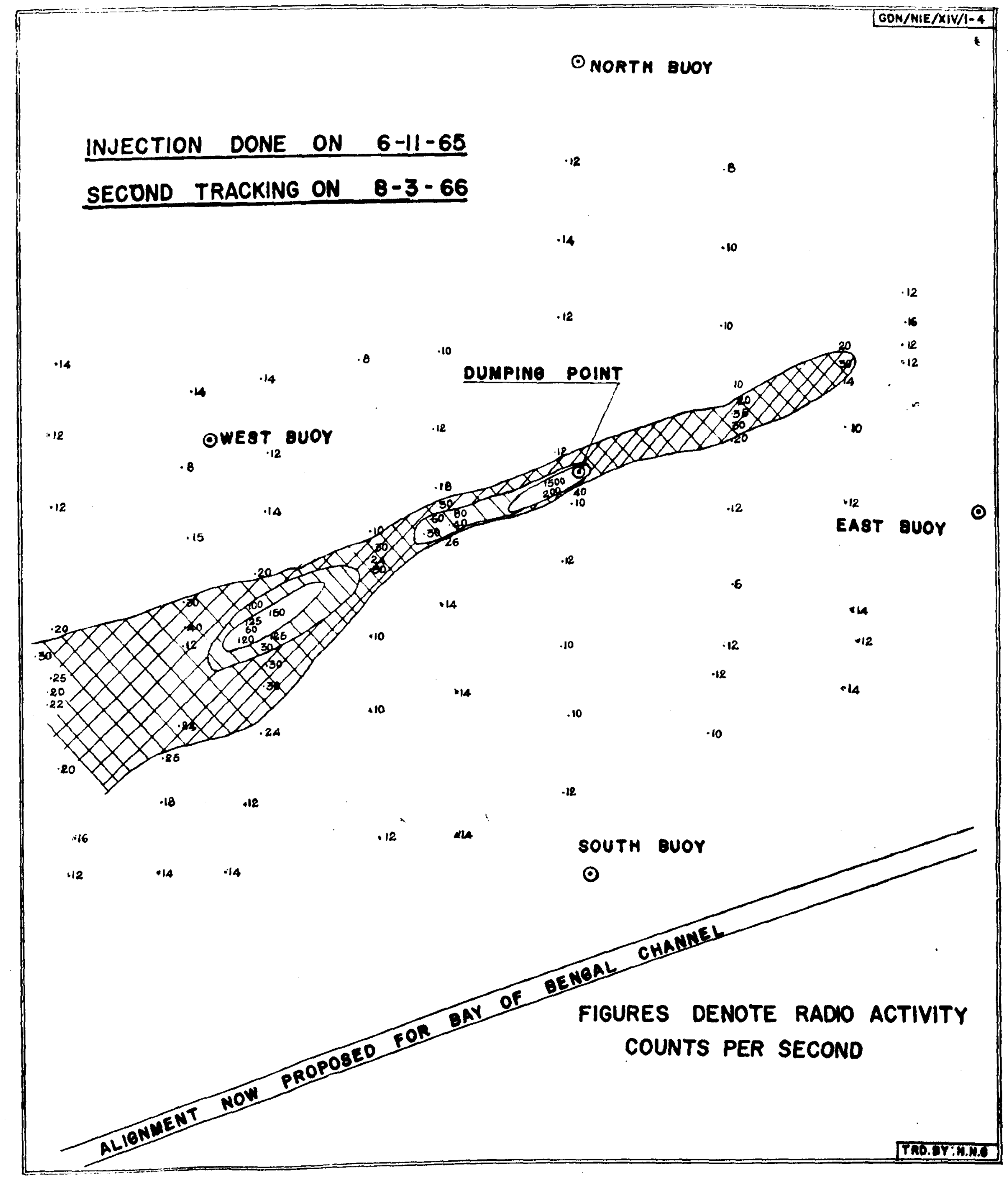
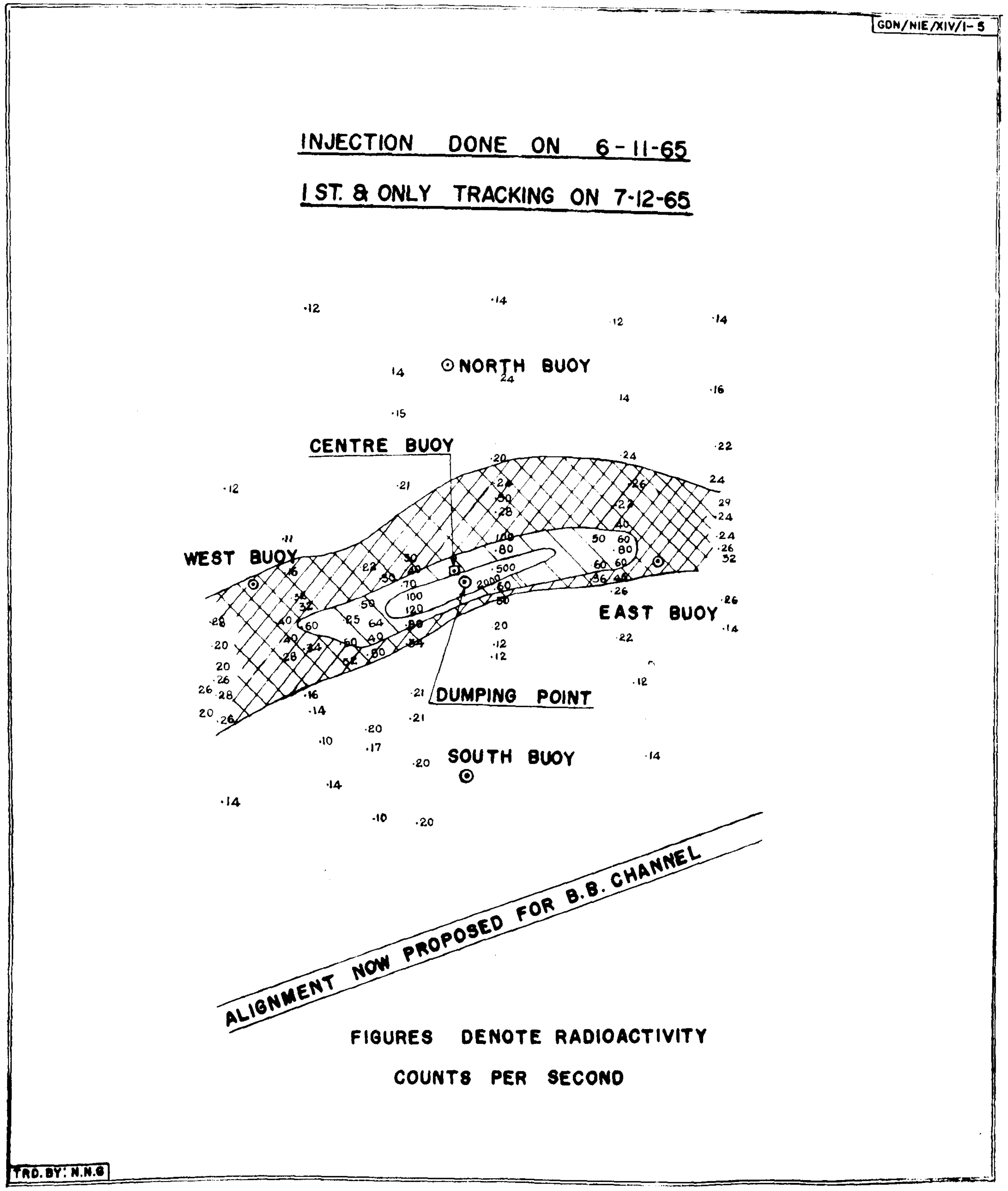
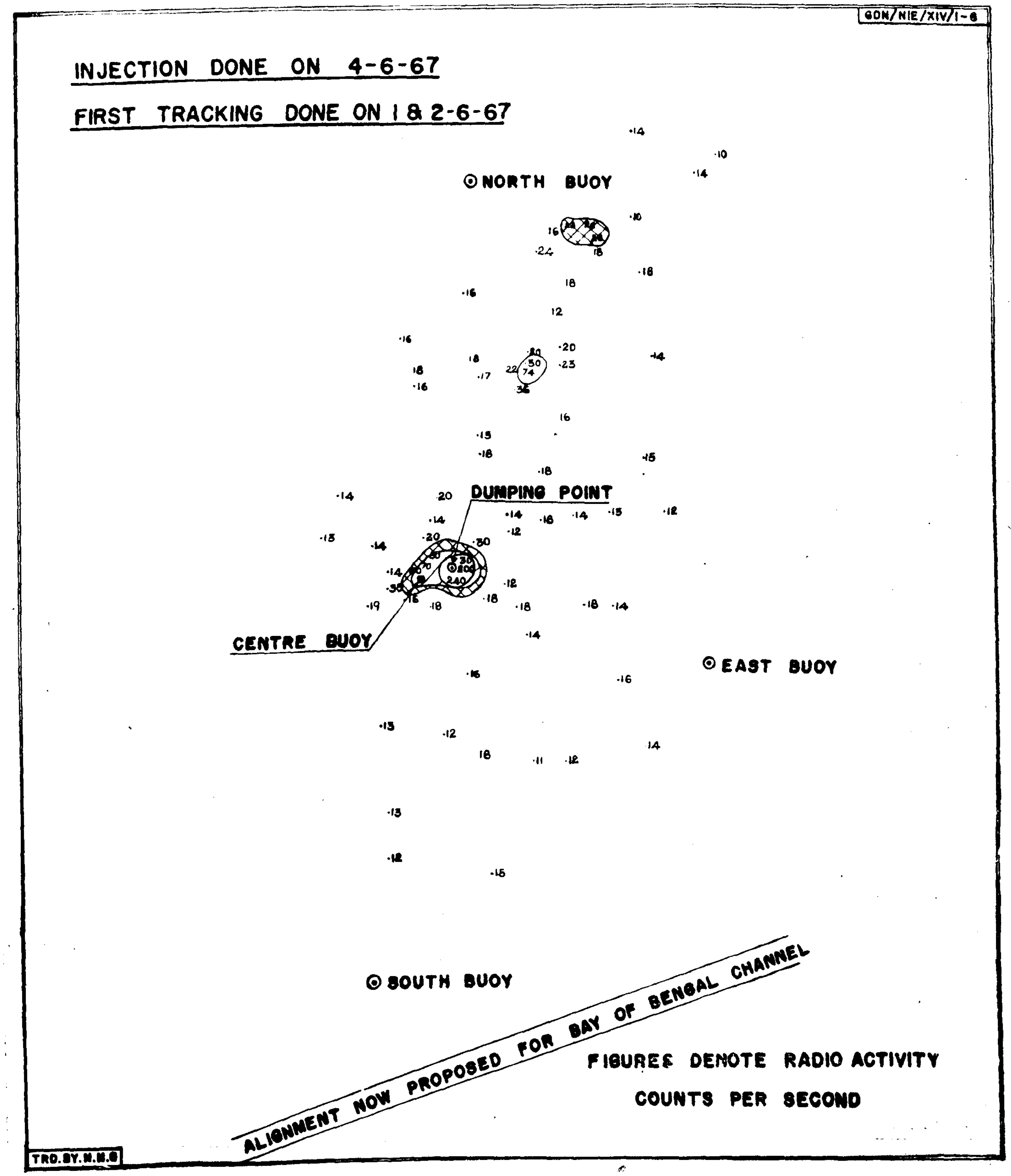
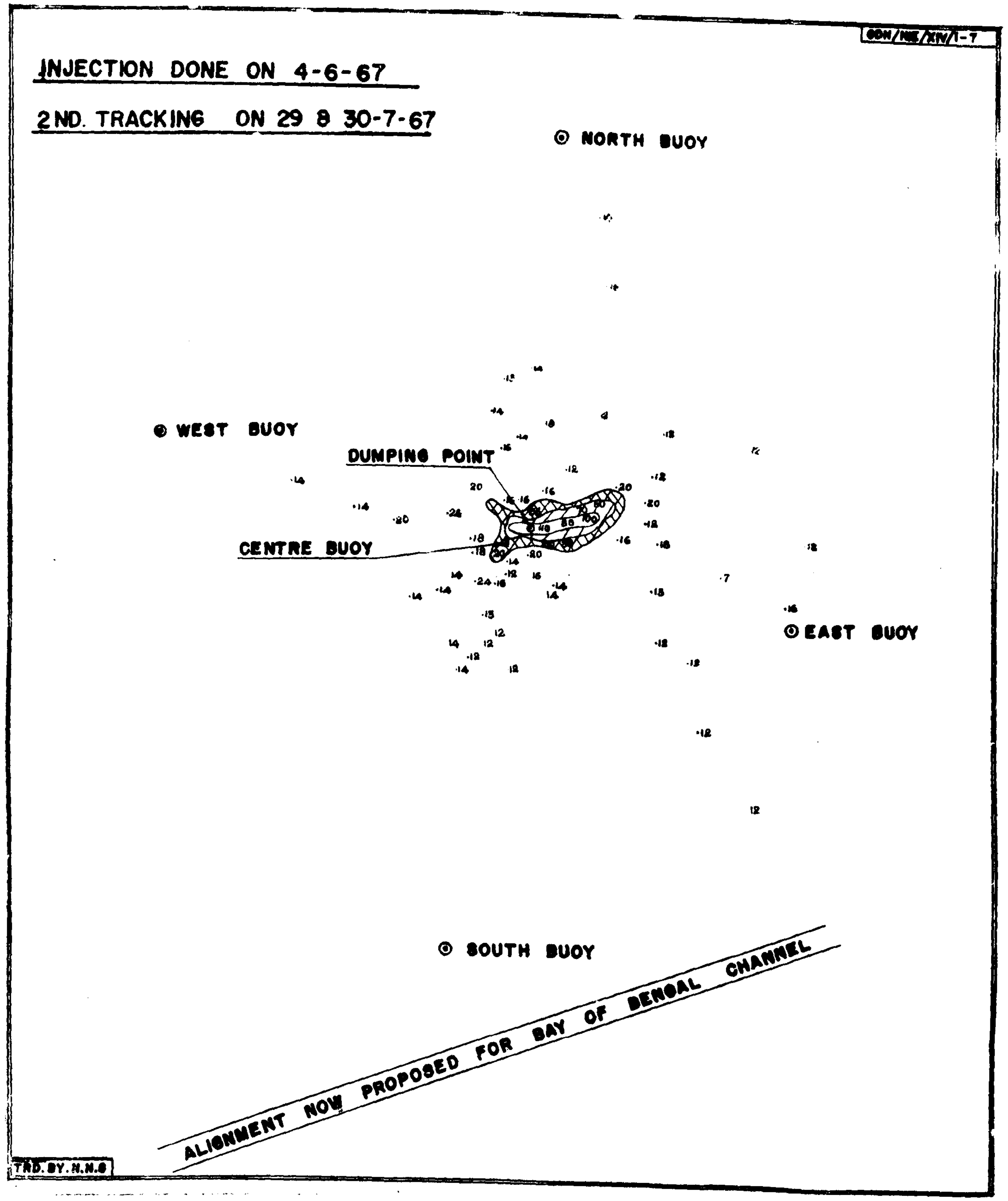
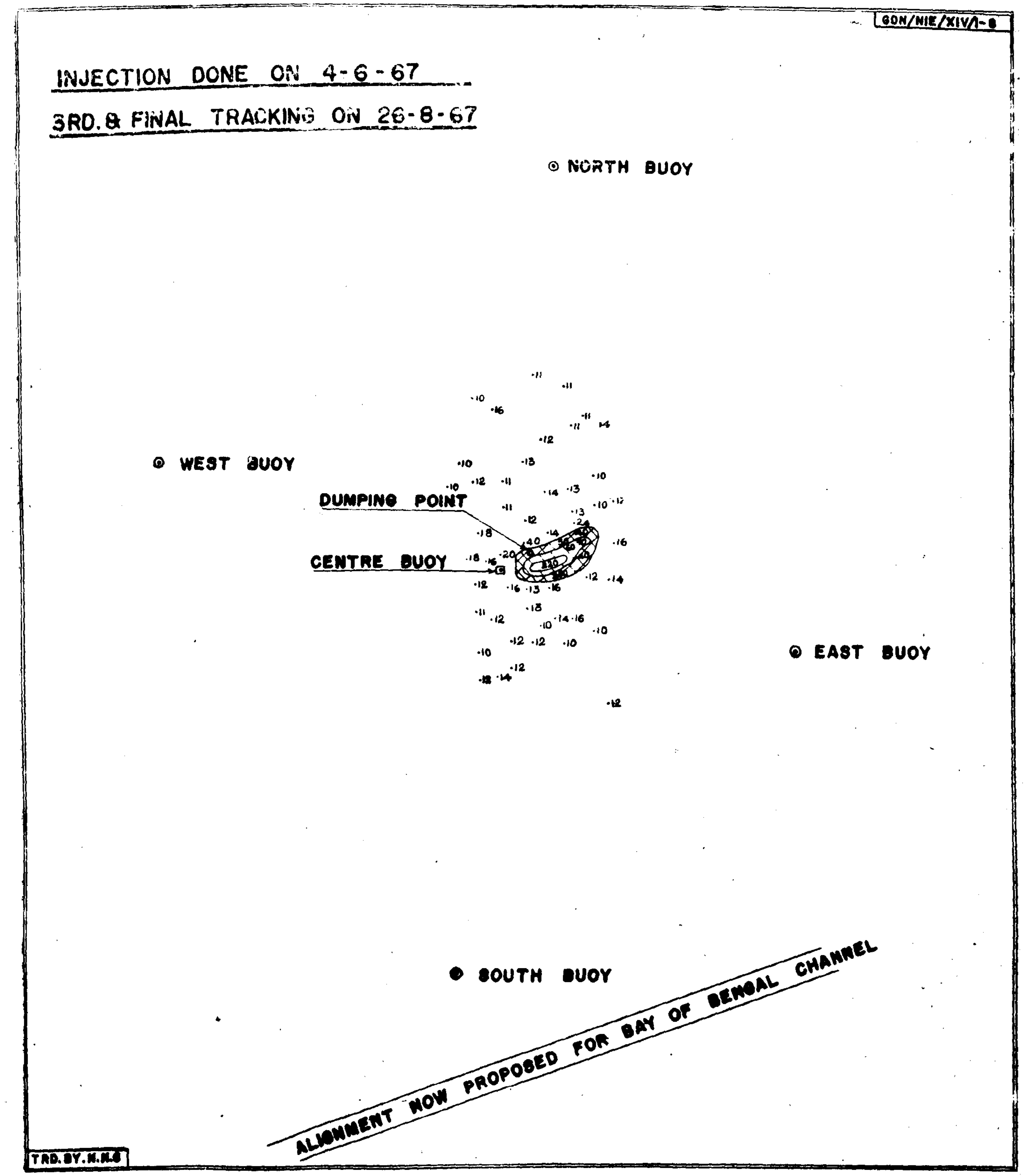

GDN/NIE/XIV/I-4
NORTH BUOY
INJECTION DONE ON 6-11-65
SECOND TRACKING ON 8-3-66
DUMPING POINT
WEST BUOY
EAST BUOY
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR BAY OF BENGAL CHANNEL
FIGURES DENOTE RADIO ACTIVITY
COUNTS PER SECOND
TRD.BY:N.N.G


GDN/NIE/XIV/1-5
INJECTION DONE ON 6-11-65
1 ST. & ONLY TRACKING ON 7-12-65
NORTH BUOY
CENTRE BUOY
WEST BUOY
EAST BUOY
DUMPING POINT
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR B.B. CHANNEL
FIGURES DENOTE RADIOACTIVITY
COUNTS PER SECOND
TRD. BY: N.N.G


GDN/NIE/XIV/1-6
INJECTION DONE ON 4-6-67
FIRST TRACKING DONE ON 1 & 2-6-67
NORTH BUOY
DUMPING POINT
CENTRE BUOY
EAST BUOY
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR BAY OF BENGAL CHANNEL
FIGURES DENOTE RADIO ACTIVITY
COUNTS PER SECOND
TRD. BY. N.N.G


GON/NIE/XIV/1-7
INJECTION DONE ON 4-6-67
2ND. TRACKING ON 29 & 30-7-67
NORTH BUOY
WEST BUOY
DUMPING POINT
CENTRE BUOY
EAST BUOY
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR BAY OF BENGAL CHANNEL
TRD. BY. N.N.G


GON/NIE/XIV/1-8
INJECTION DONE ON 4-6-67
3RD. & FINAL TRACKING ON 26-8-67
NORTH BUOY
WEST BUOY
DUMPING POINT
CENTRE BUOY
EAST BUOY
SOUTH BUOY
ALIGNMENT NOW PROPOSED FOR BAY OF BENGAL CHANNEL
TRD. BY. N.N.G

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A number of mark buoys were laid on the sea in the proposed channel region. The positions of these mark buoys, were fixed by Astronomical Survey initially and later more accurately by Trignomatrical Survey from the Light House tower at point Calomere and two more tall towers specially erected on the land end. The Ferry Steamer T.S.S. Irwin was requisitioned for dumping the Radio Active material and tracking. During the tracking, the ships positions were continuously recorded by the Survey Wing to make the tracking chart.

Two dumping sites were selected one at about the shallow west place in the channel alignmentin about 22 feet of water and the other about 15 miles westwards in the alignment in about 36 feet of water. Dumping timings were chosen to lie just before the onset of the north-east monsoon and again ahead of the south-west monsoon. Trac king was done during and after these respective monsoons.

Glass containing Scandium 46 crushed to the mean particle size of 0·036 mm to correspond to that of the bed sand were filled in aluminium capsules and irradiated for 12 days in the Reactor. This was stored in lead shielded pots and transported to site. The radio active material was transferred into the injection apparatus by long handled tongs. The apparatus was lowered on to the sea bed and the injection was actuated by nitrogen gas allowed under pressure.

Tracking was done by dragging a sledge on sea bed from the side of the ship. The sledge carried a brass cylinder containing G.M. counters from which cables were brought to the deck of the ship. Tracer strength at the first site was 35 curies and that at the second site was 25 curies.

IV. OBSERVATIONS AND RESULTS :

Tracking was done every month for 3 months after injection.

V. CONCLUSION :

The tracer studies indicated the following :—

(i) The littoral drift of sand seen on the east coast on India has no influence on the bed sand movement in the channel region.

(ii) The bed sand movement was small and was parctically in the same direction as the alignment of the channel.

(iii) This help us to conclude that—

(i) Very little bed silt would move from the sides into the channel and hence the silting will be of small magnitude and

(ii) Since the bed sand movement is only parallel to the channel it is enough if the dredged material is dumped 4 to 6 miles away from the channel on either side without fear of receiving it back.

The Radio Active Tracer studies thus confirmed that the Project is technically feasible and made it possible to work out realistic estimates of silting in the channel and maintenance dredging.

NOTE ON HOT FILM AND HOT WIRE ANEMOMETRY

BY

THIRU N. V. PUNDARIKANTHAN

1·0. *INTRODUCTION* :

In the experimental investigations of fluid flow a great number of methods, techniques, and instruments have been developed and used. For making turbulence measurements or other measurements in turbulent flows the application of anemometry has expanded greatly due to better equipment and more interest in details of flow. Turbulence measurements in air flow using hot wire anemometry have greatly increased our basic knowledge of aerodynamics and contributed to our understanding of hydrodynamics. In this paper an attempt has been made to discuss and review the theory and application of hot wire anemometry to fluid flows (water and air).

2·0. *TURBULENCE MEASUREMENTS* :

The main difficulty in measuring turbulence is caused by the fact that turbulence is a random, fluctuating flow and three dimensional. In hot wire anemometry a detecting element is introduced into the flowing fluid and turbulence quantities are measured by the changes of a mechanical, physical, or chemical nature that occur in this element. If any amount of reliability should be placed on these readings, the following requirements should be satisfied.

1. The detecting element introduced into the flowing field must be so small that it causse only the minimum admissible disturbance of the flow pattern.

2. The instantaneous velocity distribution must be uniform in the region occupied by the element. If we confine our measurements to flows of low or moderate velocities, the size of the sensing element should not exceed, say, 1 mm.

3. The inertia of the instruments must be low, so that response to even the most rapid fluctuation is practically instantaneous.

4. The instrument must be sufficiently sensitive to record small differences in the fluctuation ; these differences are often only a few percent of the mean value.

5. The instrument must be stable so that no noticeable change occurs in the calibration para-meters during at least one test-run.

6. The instrument must be sufficiently strong and sufficiently rigid to excludes vibrations or motions caused by the turbulent flow.

Hot wire anemometer is the only instrument that has been developed so far that reasonably satisfies the above mentioned requirements—although, of course, it has its limitations.

2.0. *PROBES* :

The sensor is heated above the ambient temperature of the surrounding fluid by passing an electrical current through a resistance materials. Flow of the fluid over the element cools it by forced convection. This cooling of the element is a function of the velocity of flow, viscocity and thermal conductivity of fluid : temperature, density, length of element and thickness or diameter of element.

The element or sensor may be used to sense flow velocity, temperature pressure, mass flow, etc;

Either hot wires or films can be used as sensors, the method of application and data reduction being the same in both cases.

2.1. *HOT WIRES SENSORS* :

A hot wire type sensor must have two characteristics to make it a useful device :

(A) A high temperature coefficient of resistance.

(B) An electrical resistance such that it can be easily heated with an electrical current at practical voltage and current levels.

The most common wire materials are tungsten, platinum and a platinum-iridium alloy. Tungsten is presently the more popular hot wire material. A thin platinum coating is usually applied to improve bond with plated ends and the support needles.

2.2. *HOT FILM SENSORS* :

The hot film sensor is essentially a conducting film on a Ceramic substrate. One of the sensors shown in the attached figure is a quartz rod with a platinum film on the surface. Gold plating on the ends of the rod isolates the sensitive area and provides a heavy metal contact for fastening the sensor to the supports. When compared with hot wires the cylindrical hot film sensor has the following advantages :—

(A) Better frequency response than a hot wire of th same diameter because the sensitive part of the sensor i distributed on the surface rather than including the entire cross-section as with a wire.

(B) Lower heat conduction to the supports for a given length to diameter ratio due to low thermal conductivity of the subsrate material. A shorter sensing can be used.

(C) More flexibility in ensor configuration. Wedge, conical, cylindrical, parabolic and flat surface shapes are available (as shown in figure).

(D) Less susceptible to fouling and easier to clean. A thin quartz coating on the surface resists accumulation of foriegn material.

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The metal film thickness on a typical film sensor is less than 1,000 Angstrom units, causing the physical strength and the effective thermal conductivity to be determined almost entirely by the substrate material. Most films are platinum due to its good oxidation resistance and the resulting long term stability. The low strength of platinum is not important since it is supported by the quartz rod. The ruggedness and stability of film sensor have led to their use for many measurements that have previously been very difficult with the more fragile and less stable hot wires. Even though film sensor have basic advantages, hot wire sensors give superior performance in applications requiring maximum frequency response, minimum noise level, and very close proximity to a surfase

2.3. *PROBE SHAPES*:

It has not been possible to measure the characteristics of turbulence in water with the same precision and ease, as in air. It is due to the fact that stable drift free operation of hot-wire anemometers in water is not possible, for the wires are contaminated by dissolved gases, dirt and chemicals in the water; electrolysis of the wire; and conductivity of the water. The development of hot-film sensors to replace the wire has eliminated the instability which results from the electrolysis of the probe and conductivity of the water by having a thin coating of quartz fused over the platinum to insulate the conductor from the fluid. The cone shape is used primarily in

water applications where its shape is particularly valuable in preventing lint and other fibrous impurities form getting entangled with the sensor. Hot film sensors are as popular with air and gas measurements as they are with water.

3.0. *CONTROL CIRCUITS*:

In successfully using an anemometer for any specific fluid mechanics measurement the selection of a sensor is of primary importance. However, this sensor must be controlled with an electronic circuit and some basic knowledge of its function and operation is essential.

3.1. *CONSTANT CURRENT—CONSTANT TEMPERATURE—ANEMOMETER*:

There are two modes of operation of hot wire anemometers: (1) The constant current method, in which the electrical current is kept constant, and thus the sensor electrical resistance fluctuates with velocity fluctuations; and (2) The constant temperature (constant resistance) method in which, by using an electrical feedback system, the current flucatuates with the fluctuating velocity. The constant temperature system is more compatible for wire type film type sensors and for gas and liquid mediums and is easier to use. Several high-quality constant temperature anemometers are now commercially available.

3.2. *SENSOR OPERATING TEMPERATURE*:

To operate a sensor it is necessary to determine and set the proper operating, temperature for the application. The overheat ratio which is $K = R_h/R_c$ where R_h =

operating (hot) resistance of sensor; R_c = resistance of sensor at fluid (cold) temperature is to be fixed depending on the medium of flow (air, water) and the material of sensor and is the following relationship:

$$K = \frac{R_h}{R_c} = 1 + d_y\,(t - t_e)$$

d_y = temperature coefficient of resistance for the sensor material at temperature. t_e.

t = Sensor operating temperature.

t_e = environmental fluid temperature.

In water K is set at 1.05 to 1.10 and in air K is set at 1.6 to 1.8. Higher values of K are not used in water because the temperature of probe would cause boiling.

4.0. *THEORY OF HOT WIRE ANEMOMENTR*:

The theory of the constant temperature hot-wire anemometer is reviewed here. It measures the rate of heat transfer between the constant temperature of a cylindrical sensor and the surrounding environment. This environment includes both the moving fluid, the sensor is immersed in and the supports holding the sensor.

From various heat transfer relationships the following relation may be written for a cylinder.

$$P = (A + BV^n)\,(t_s - t_e) \ldots\ldots\ldots (1)$$

Where P = Heat flux dissipated by sensor

$$A = \pi K_f L C \left(\frac{t_f}{t_e}\right)^{0.17}$$

$$B = \pi K_f L D \left(\frac{t_f}{t_e}\right)^{0.17} \left(\frac{d_o}{\nu_f}\right)^n$$

Where

L = sensor length

C, D, n = are constant values depending on cylinder Reynolds No. $\left(\frac{Vd}{\nu_f}\right)$

K_f = Thermal conductivity of environment fluid

t_f = film temperature $= \frac{t_s + t_e}{2}$

t_e = environment temperature

t_s = sensor surface temperature

d_o = sensor diameter

V = Velocity

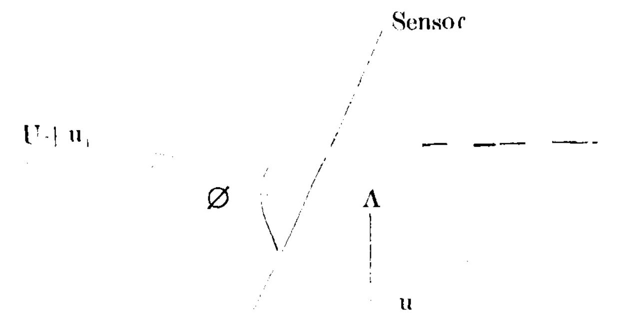
ν_f = Kinematic viscosity of fluid.

The values of A and B will be calculated by above formulae or obtained by Calibration.

4.1 *VELOCITY MEASUREMENTS WITH ONE SENSOR*:

The hot wire or cylindrical hot-film sensor responds to changes in the velocity normal to the axis of the sensor. A single sensor is primarily sensitive to the fluctuations in velocity parallel with the mean flow direction when the sensor is oriented perpendicular to the mean flow Normally, cylindrical sensors are considered insenstive to any velocity components along their axis.

For a general case of sensor configuration, method of calculating fluctuating component is indicated below :—



$$V = \sqrt{(U + u_1)^2 + u^2} \quad \ldots (2)$$

where

V = Instantaneous velocity normal to sensor

U = mean velocity of stream

u_1 = fluctuating component of velocity parallel to mean flow velocity

u_2 = fluctuating component perpendicular to both mean flow and sensor axis.

Equation (2) states that the velocity past the sensor, V, is the vector sum of the two comopnents, $U + U_1$ and u.

$$V^n = U^n \left(1 + n\frac{u_1}{U} + \frac{n(n-1)}{2}\frac{u_1^2}{U^2} + \frac{n}{2}\frac{u_2^2}{U^2} + \right.$$

$$\left. \frac{n}{2}(n-2)\frac{u_1 u^2}{U^3} + \frac{n(n-1)(n-2)}{16}\frac{u_1^3}{U^3} + \ldots\ldots\right) \ldots (3)$$

with the assumption that $u_1 << U$
$u << U$

equation (3) reduces to

$$V^n = U^n \left(1 + n\frac{u_1}{U}\right) \ldots\ldots\ldots\ldots (4)$$

If P is a small variation about a mean power level $\bar{p}$ caused by a change in u.

$$P = \bar{p} + P = (A + BU^n)\left(1 + n\frac{u_1}{U}\right)(t_s - t_e) \ldots\ldots\ldots (5)$$

Equation (5) gives the instantaneous electrical power in put to the sensor as a function of U and u_1.

Average power level $\bar{p} = (A + BU^n)\,(t_s - t_e)$ .. (6)

Power level at zero velocity $P_o = A\,(t_s - t_e)$ .. (7)

Combining equation (5) to (7), we can write

$$\frac{p/n}{\bar{p} - P_o} = \frac{u_1}{U} \quad \ldots (8)$$

The average value of p and u_1 are, by definition, zero. Therefore, the root mean square (rms) value is normally used as a measure of turbulence. With

$\sqrt{\overline{u_1^2}}$ = root mean square value of turbulence fluctuations in mean flow direction.

$\sqrt{\overline{p^2}}$ = root mean square value of power
Equation (8) can be written as

$$\frac{\sqrt{\overline{p^2}}/n}{\bar{p} - P_o} = \frac{\sqrt{\overline{u_1^2}}}{U} \quad \ldots (9)$$

This equation gives the relation between the r m s value of electrical power to the sensor, $\sqrt{\overline{p^2}}$ and the r m s value of the velocity fluctuations in the mean flow direction, $\sqrt{\overline{u_1^2}}$

The above equations are written in terms of power to the sensor rather than bridge voltage which is the basic signal output from the anemometer circuit. Some systems indicate power to the sensor in addition to bridge voltage. A calibration chart for the typical hot wire sensor in air for the output voltage and a linearized output is shown in graph.

Equation (9) has adequate accuracy for most turbulent work. High accuracy claims may not be made when making measurements of high turbulence intensity.

5.0. *DIRT AND IMPACT STRNGTH*:

Foreign matter in the flow gradually accumulates on a hot wire and ultimately changes its calibration by altering the heat transfer rate. Near zero velocity the heat transfer rate is little affected or may actually be increased by the dirt accumulation (the increased surface area off-setting the insulation of the dirt film) but at high velocity the heat transfer rate is always reduced. The result is poorer resolution of velocity changes at all velocity levels. Platinum and nickel wires may be

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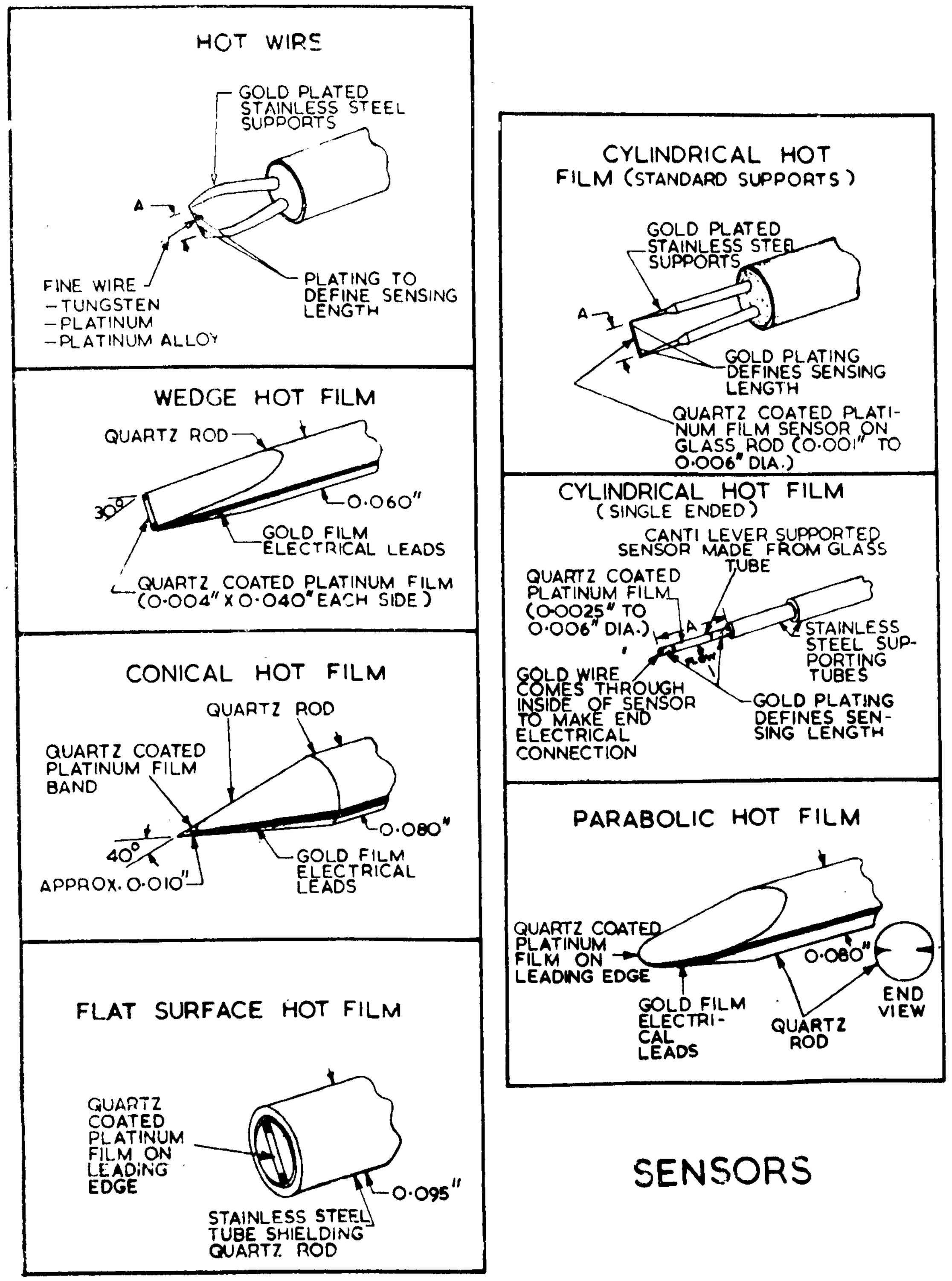
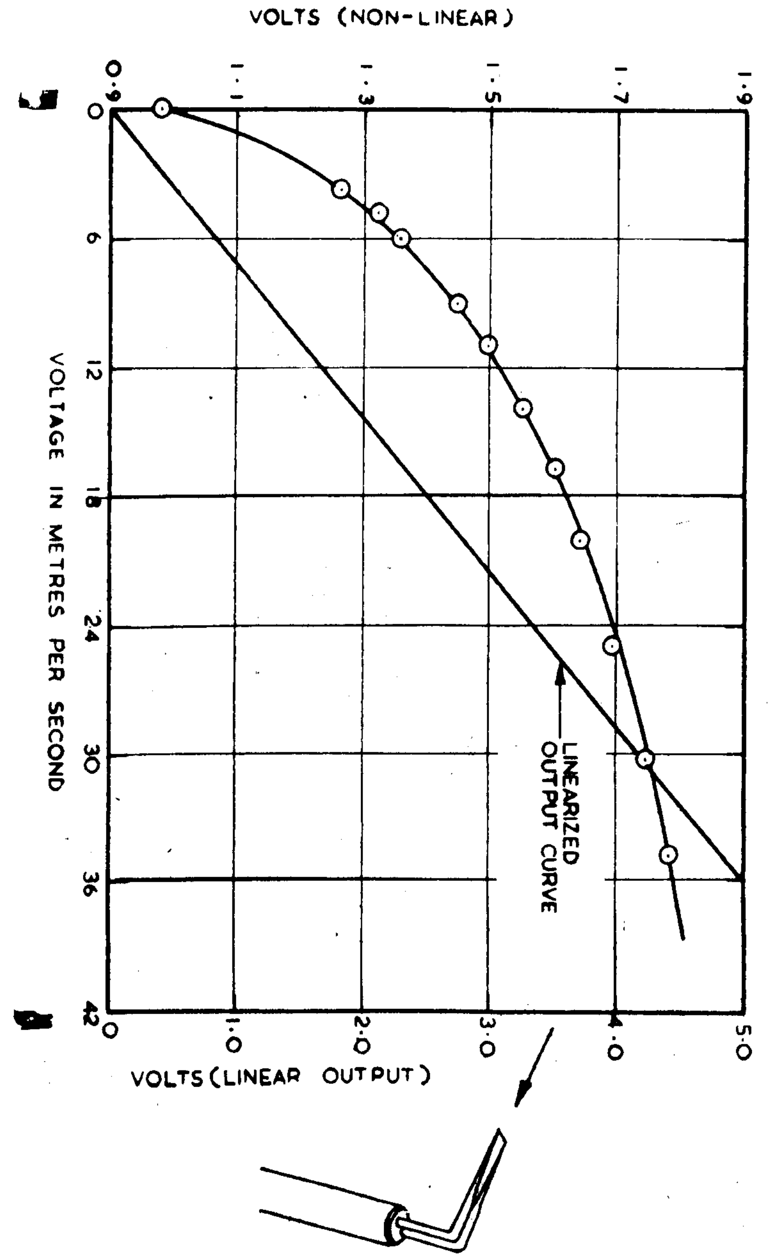


SENSORS



CALIBRATION FOR A 0·00015 INCH (0·0038 mm) DIA. HOT WIRE IN ATMOSPHERIC AIR (0-40 m/SEC.)

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cleaned very effectively by heating to a dull red glow for a few seconds. Tungsten wires (which will burn out in air before reaching red glow temperature) must usually be cleaned with chemical solutions such as denatured alcohol, Potassium dichro nate saturated with sulphuric acid. Method of cleaning is by vibrating wire or slightly agitating the liquid acoustically with frequencies of 15 to 60 c by means of a loudspeaker.

Rate of accumulation of dirt increases sharply with increased velocity not only because the wire sweeps out a larger air volume per unit time but also because small particles gain enough inertial to strike the wire than follow the stream around the wire. In ordinary industrial environments, without air filtering, cleaning will be required every few hours at velocities below 30 mps, but may be required every few minutes at a velocity above 120 mps to avoid large corrections for dirt accumulation.

In most high speed applications such as a laboratory wind tunnel testing, there are large enough dirt particles to present a wire breakage hazard. Pure platinum otherwise an ideal wire material has low strength and is usually ruled out when the velocity exceeds 100 mps unless the air stream is exceptionally clean. Tungsten has highest strength and is universally used in high speed testing unless air temperature exceed about 600°F (the oxidizing temperature for tungsten) in which caes compromise material such as nickel or 80 per cent platinum—20 per cent iridium are employed.

6.0. *CONCLUSION* :

Many of the fluid flows that occur are turbulent in nature. To theoretically solve any turcobulent flow problem is next to impossible. Attempts to solve them by numerical methods may nsume so much time and money which is clear in the words of Stephen J. Kline who gives an example (6) : "To solve the most elementary problems in turbulent flow using a digital computer of the largest kind available in 1971 would take a running time of 30 years. Even if we could wait that long, the cost of running at current rates would be about 130,000,000 (dollars) for each point of output ; most laboratories can do experiments a good bit cheaper than that ". The only effective way of making measurement of turbulence in laoratories is by hot wire anemometry. Even though the difficulties in making hot-wire anemometer turbulence measurements are numerous and troublesome, and making correct measurements is as difficult, this has to be improved and perfected in course of time to increase our basic knowledge of hydrodynamics.

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LOAD TESTS ON UNDER REAMED PILES

BY

THIRU *R. RAJARAMAN.

1. *I SNTRODUCTION*

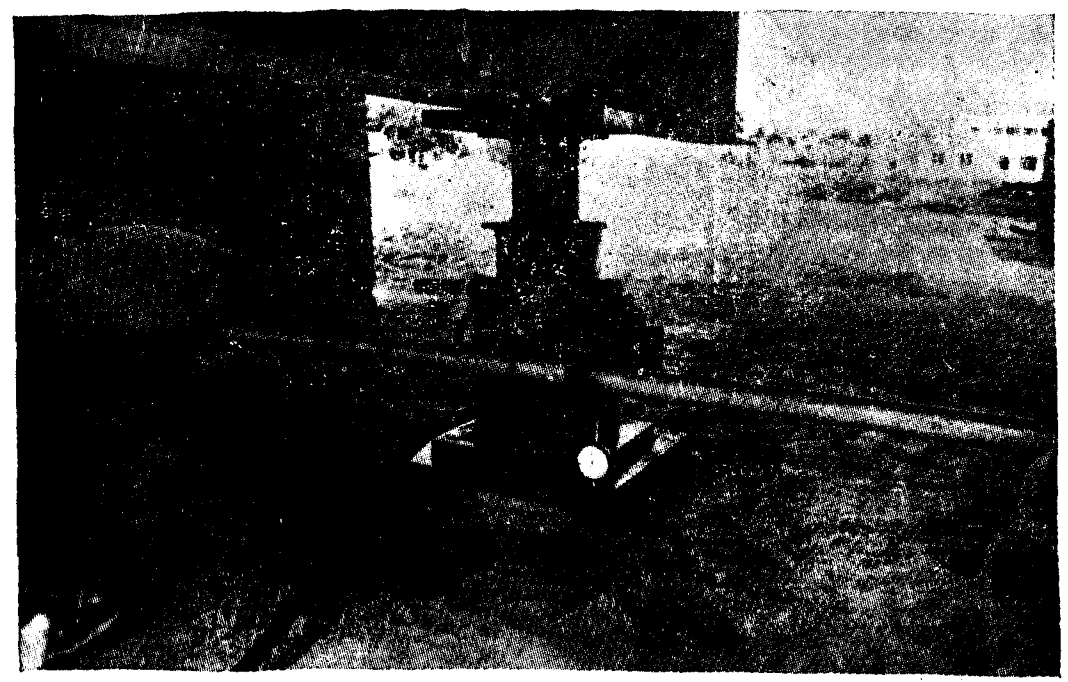
1.1. In many parts of the city of Madras swelling type of clays are present to appreciable depths from ground level and frequently buildings constructed in such areas accord. ing to conventional methods have sufferred damage. Such soil shave been met with in Anna Nagar, Raja Annamalai puram, Guindy, T. Nagar Nandanam, Saidapet, etc- Table No. 1 furnishes typical properties of these soils.

1.2. The conventional methods adopted for building foundations in such soils include excavation of undesirable soils and back-filling with sand wherever possible, adoption of as deep a foundation as economically feasible, use of sand filling in the bottom and sides of the found rajtdation trench, provision of an R.C. and T beam at foundation level, provision of continuou S.R.C. beams at plinth and lintel level etc. A detailed treatmentof such methods is furnished in a paper by C. Chandrahasan. (1). However, some of the buildings have been found to be affected even after provision of such treatments. Further the cost of the building increases appreciably by the provision of such additional features.

1.3 Presently, the use of the under reamend piles is finding increased fauvour with Engineers and Builders in the City in view of the reduction in cost possible and the claim that the provision of such a foundation fully overcomes, the deleterious effects of the swelling properties of the clay. Boring and under reaming tools are more readily available and also as the time required for execuation of the foundation work upto ground level is comparitively ess and as the site work is handled more elegantly, the adoption of under-reamed piles is increasing day byday. However, most of the smaller building contractors of the city are not well versed with the execution of such works. A few cases of buildings constructed with under-reamed pile fonudatations have therefore shown some distress. Such defective behaviour of under reamed pile foundations has been attributed to insuffici ent formation of the bulb in the piles. It was therefore considered desirable to test a few under reamed piles so as to ensure that the piles had the designed carrying capacity and to gain confidence in- the construction techniques adopted before embarking on a project involving the construction of a large number of under-reamed piles. The present paper describes the tests carried out and the results obtained for one such project viz.,proposed building for the Indian Standards Institution Madras Branch at Guindy.

2. *DETAILS OF THE BUILDING*:—

2.1 The site is located in the Central Polytecnics campus, Adyar, next to the Institute of Catering Technology. The buildings is a 3-St oreyed framed structure. An examination oftrial pits put at the site revealed the existence of brown clay upto a depth of 1.7 m and standy clay upto 2.6 m. Both disturbed and undisturbed soil samples were collected from the pits and have been tested in the Soil Mehanics and Reasearch Laboratories.



Arrangements of RSJs., Jacks and Dial Indicator.

* Research Officer, Scil Merchanics and Research Division, Madras-5.

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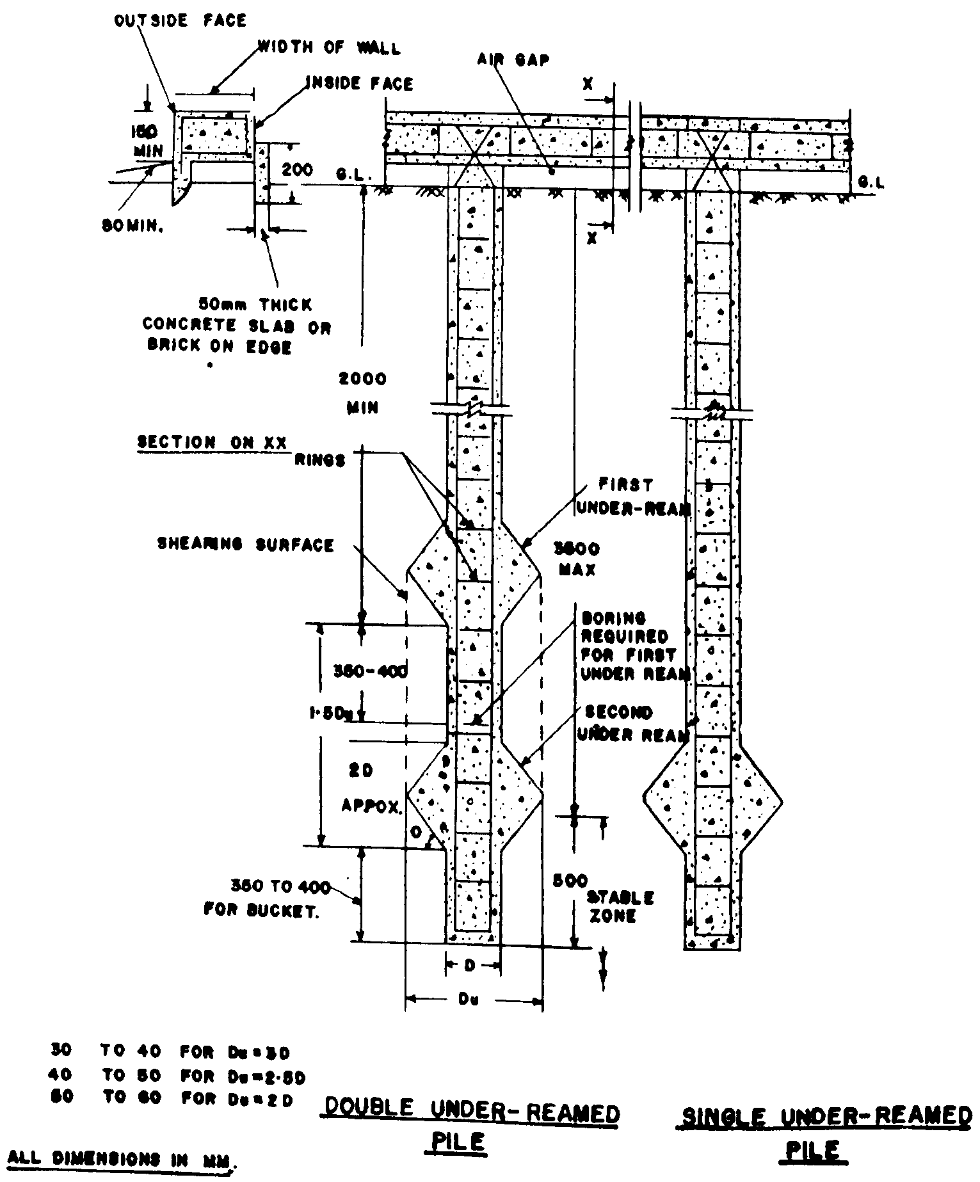

TYPICAL DETAILS OF UNDER-REAMED PILE

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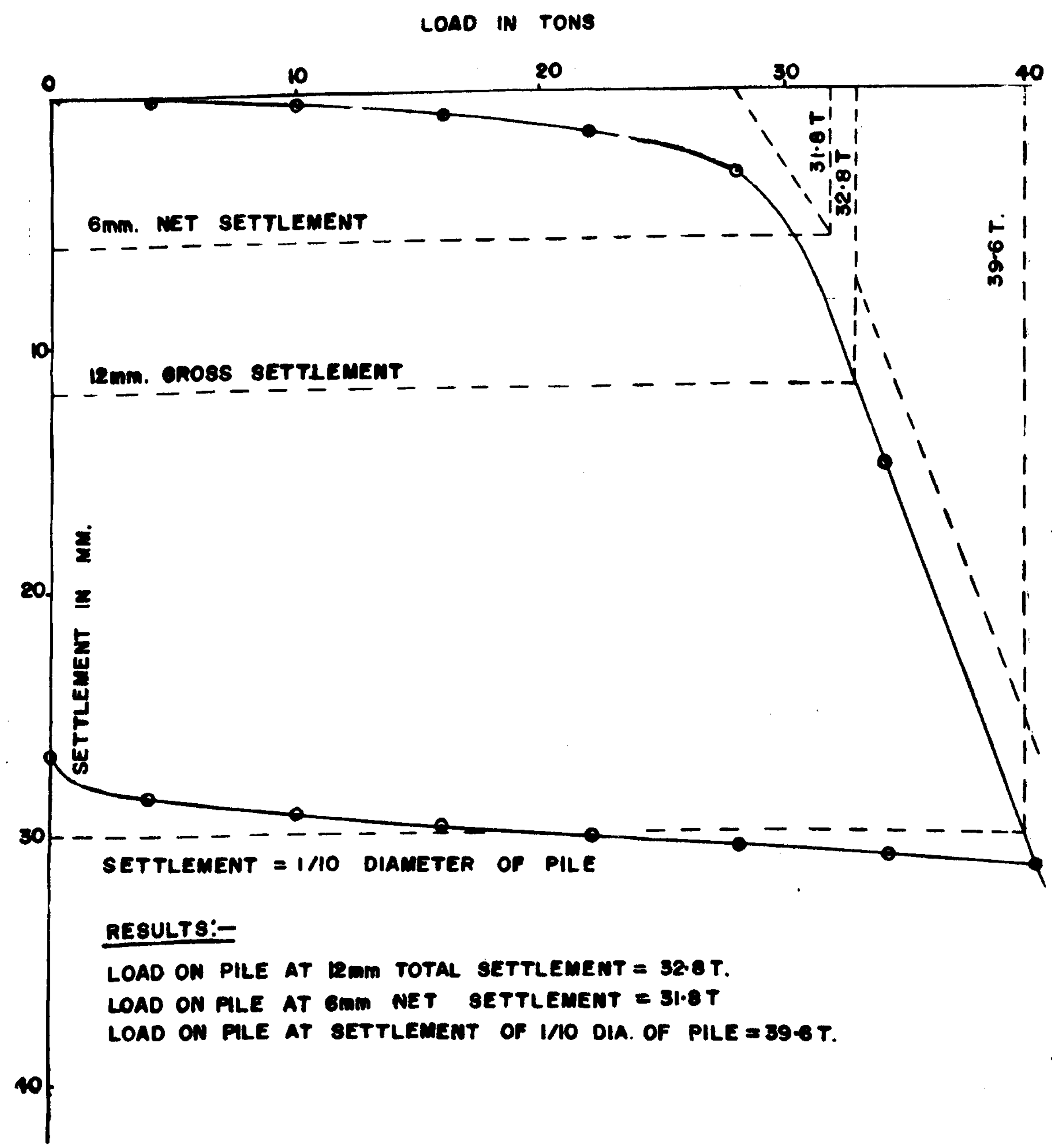

LOAD SETTLEMENT GRAPH.

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TABLE (1)

Soil Properties of typical Madras Clays.

SCHEME.

SOIL ENGINEERING RESEARCH STATION,
CHEPAUK, MADRAS-5.

NATURE OF TESTS.

CONSOLIDATED STATEMENT OF TEST RESULTS.

Location and Laboratory number.	*%Depth*	*Mechanical Analysis.* %Gravel.	%Sand.	%Silt.	%Clay.	%Total Fines.	%Liquid Limit.	%Plasticity Index.	*Classification (Casagrande).*	*Field Moisture Equivalent.* %	*Shrinkage.* %Shrinkage Limit.	Shrinkage Ratio.	%Volumetric Shrinkage.	%Linear Shrinkage.	*Compaction.* Natural Moisture Content. %	Natural Dry Density gm/cc. %	Unconfined Compressive Strength Lb./S.Ft.	*Shear Strength.* Cohesive Strength Lb./S.Ft	Angle of Friction Degrees.	*Coef. of Permeability.*
Vidyodya T. Nagar C.B.I.1.	2	..	6	26	68	94	61	33	CH	39	12	1·95	51	13	29	90	..	..	..	..
Saidapet C.B.I. 26	2	..	6	29	65	94	53	28	CH	33	11	1·96	43	11	23	98	..	..	..	..
Saidapet C.B.I. 65	2	..	16	22	62	84	50	31	CH	29	4	2·29	56	14	17	101	..	..	..	..
Annanagar 123/73	2·25	..	7	43	50	93	43	30	CH/CL	28	13	1·96	31	9	23	1·88	..	..	..	..
Annanagar 120/74	3·5	..	..	19	81	100	103	66	CH	..	..	..	..	..	..	..	..	..	..	..
Raja Annamalaipuram	1 to 5	..	6	41	53	94	55	36	CH	40	12	2·0	..	..	..	..	..	..	..	..
Shenoynagar 121/66	1·5 to 2	..	4	23	73	96	63	44	CH	58	12	1·92	88	19	..	..	..	..	..	..
Shenoynagar 66/66	0 to 2	..	3	28	69	97	48	31	CH/Cl	46	13	1·93	63	15		..	..	..	..	..
T. Nagar 22/69	2 to 3	..	1	24	75	99	61	41	CH	34	12	..	..	11	..	..	..	..	..	..
T. Nagar 42/69	0 to 1·5	..	6	28	66	94	62	40	CH	44	12	..	..	15	..	..	..	..	..	..
Nandanam 126/70	4·5	..	..	7	93	100	71	45	CH	45	14	..	..	35	..	..	..	..	..	..
Nandanam 127/70	2·5	..	6	16	78	94	68	43	CH	40	6	..	..	14	..	..	..	..	..	..
Nungambakam 127/71	2·5	..	11	25	64	89	75	49	CH	40	4	..	..	17	..	..	..	..	..	..
Nungambakam CBI 16	2	..	4	28	68	96	57	32	CH	30	10	2·01	40	11	28	84	..	..	..	..
Mount Road 110/71	0·6	..	16	31	53	84	67	47	CH	32	4	1·94	55	17	..	..	..	..	..	..
Mount Road CBI. 132	2	..	14	28	58	86	53	35	CH	31	8	2·14	50	13	19	106	..		..	..

TABLE No. 3.

Load tests on Double under-reamed pile.

Location : I.S.I. Building, Adayar.
Diameter of pile : 30 cms.
Depth of pile : 3·5 m.

Least count of settlement dialg uge 0·01 mm.
I.R. of settlement dial gauge 20·97.

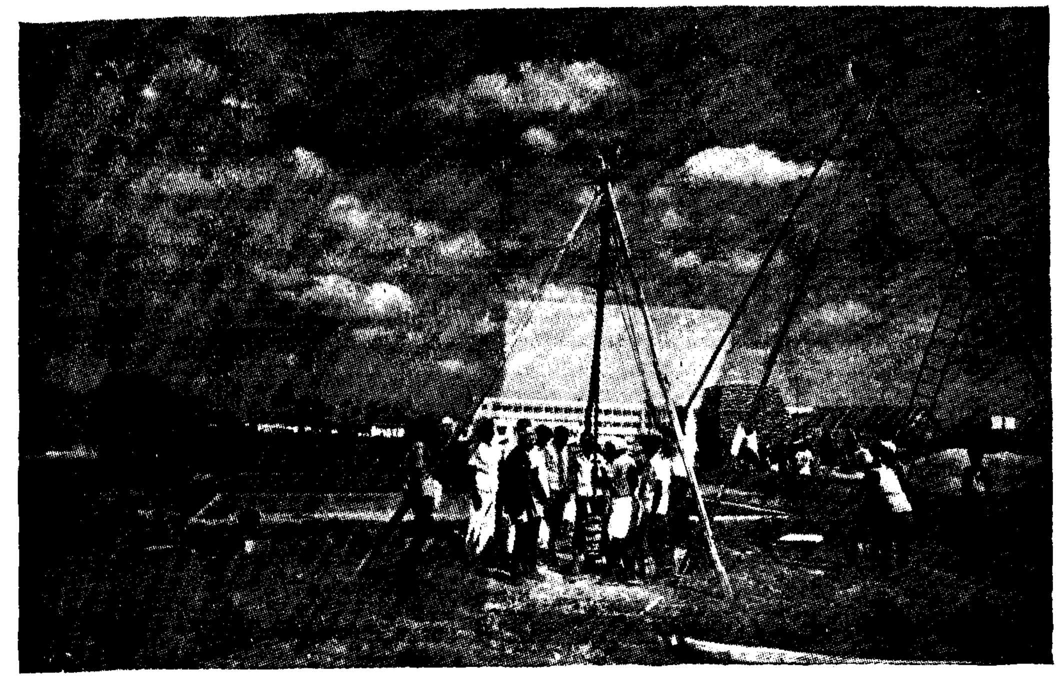
Applied load (Tons) Time (minutes).	0	4	10	16	22	28	34	40
	Settlement dial gauge readings.							
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	..	20·89	20·65	20·11	19·42	18·32	13·80	16·80
4	..	20·89	20·64	20·10	19·36	18·13	11·30	12·50
10	..	20·89	20·64	20·09	19·35	18·03	11·55	11·05
20	..	20·88	20·63	20·08	19·33	17·99	9·50	9·00
40	..	20·87	20·62	20·08	19·30	17·75	8·40	7·32
60	..	20·87	20·62	20·08	19·30	17·60	6·42	7·00
80	..	20·87	20·62	20·08	19·30	17·60	5·92	6·35
100	..	20·87	20·62	20·08	19·30	17·60	5·91	6·00
140	..	..	..	..	..	..	5·90	5·40
160	..	..	..	..	..	..	(Reset 21·55)	..
Settlement cms.	..	0·010	0·035	0·089	0·167	0·337	1·507	3·122
			Unloading.					
Settlement reading after 5 mts.	10·20	8·22	7·57	7·00	6·37	6·05	5·74	..
Settlement cms	2·642	2·840	2·905	2·962	3·025	3·057	3·088	..

TABLE NO. 4.

Safe bearing capacity of Under Reamed Piles.

Te num (1)	*Type of pile.* (2)	*Criterion used for checking carrying capacity.* (3)	*Load corres-ponding to column (3).* (4) (TONS).	*Safe bearing capacity on pile.* (5) (TONS).	*Safe bearing capacity adopted.* (6) (TONS)
1	Single under raemed pile	.. Total settlement of 12 mm.	28·0	18·6	..
		Net settlement of 6 mm.	26·4	17·6	15·8
	Diameter 30m. .. .. .. Depth 3·5 c m.	Settlement equal to 1/10 Diameter of pile (30 mm.)	31·6	15·8	..
2	Double under reamed pile..	.. Total settlement of 12 mm.	32·8	21·9	
		Net settlement of 6 mm.	31·8	21·2	19·8
	Diameter 30 cms. .. .. .. Depth 3·5 m.	Settlement equal to 1/10th Diameter of pile (30 mm.)	39·6	19·8	

30



Vilors of the site showing the borting operasions

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ENERGY AND MOMENTUM COEFFICIENTS

by

THIRU D. CHANDRASEKARAN* & THIRU R. SAKTHIVADIVEL **

1. *INTRODUCTION* :—

In many fluid flow problems, it has often become a necessity to compute the energy and the momentum flux of a flowing fluid. The energy principle is generally used for flow computations and only when a significant internal loss exists in the flow, then the momentum principle is made use of. The kinetic energy and the momentum flux of the fluid can be obtained by integrating the point velocity with respect to the area of flow. Such a procedure would be simpler if the velocity distribution is uniform across the depth. For rear fluid flow with non-uniform velocity distributions, the integration may be involved and the solution cannot be easily obtained. In such cases, the kinetic energy and the momentum flux can be computed directly from the mean velocity of flow using certain coefficients to account for the non-uniform distributions. A coefficient for computing the kinetic energy was first proposed by Coriolis and another for the momentum flux by Boussinesq. Since then, these coefficients were computed for a number of velocity distributions, and the results were reported. However, a critical review and comparison of these coefficients obtained for different velocity distributions are not available. In this note the coefficients obtained for different velocity distributions are summarised and compared.

2. *VELOCITY PROFILES* :—

Different profiles for the non-uniform distribution of velocity in turbulent flow have been proposed, making different assumptions with varying degrees of plausibility Prandtl (1)propounded the logarithmic law of distribution which can be applied in the neighbourhood of the wall.

This velocity profile has a kink at the point of maximum velocity .The velocity profile a proposed by Von-karman (1) also has the same defect. The one-seventh power law established by Blasius (1) is applicable only in the transitional regime of flow and the power is slightly different for higher Reynolds numbers Recently, a velocity distribution based on the balance of the rate of energy lost due to molecular fractiion and the flux of the momentum from the wall has been presented by Zagustin (2). This law is free from the defects of other velocity distributions and yields better results when applied to practical problems (3). In laminar flow the velocity distribtuion is parabolic (1) as shown by Hagen and Poizeuille. Rehbock (4) proposed a hypothetical linear distribution for the velocity in laminar flow.

3. *COMPARISON* α *and* β *sign* :—

The energy coefficient α and the momentum coefficient β are respectively obtained from the equations.

$$\alpha = \frac{\int_0^A u^3\, dA}{V^3 A} \quad \text{and} \quad \beta = \frac{\int_0^A u^2\, dA}{V^2 A}$$

Wh re u=V elocity of flow at any distance y form the wall V=Mean velocity of flow and A=area of flow (Fig.1). In the figure, U refers to the maximum velocity occurring at a distance of h. The different velocity profiles (Table 1) were introduce in the above equations and the values of α and β were computed with an IBM-1620 computer for pipe flow and wide open channel flow. The computed values are tabulated in Tables 1 and 2 together with the values of pipe factor. The pipe factor is defined as thet ratio of the Mean veloc ty V to the maximum velocity, U. The usefulness of the pipe factor is that the mean velocity of flow can be easily computed, if the maximum velocity is known. In Table 1, V_*=shear velocity which is equal to $V\sqrt{\frac{f}{8}}$ for pipe flow in which f " refers to the friction factor and $V/c\sqrt{g}$ for open channel flow in which C refers to Chezy's coefficient and g, acceleration due to gravity, i=hydraulic gradient in pipe flow and bed slope in channel flow, γ=dynamic viscosity of fluid, w its specific weight and k=von-karman's constant taken to be 0.4 Table 2 gives the numerical values of α and β computed with the help of Table 1 for different values of f and C. The values of α and β (Table 1).

(Table 1) for exponential velocity distributions, namely, Hagen-Poiseuilles, parabolic law, Rehbock's linear power law and Blasius' one-seventh power law are independent of the friction parameters f and C. Among these laws, Rehbock's law furnishes the highest values α =5 and β=2·333 for the case of open channel flow. The variations of α and β (from Table 2) with respect to f and C are shown in Fgs.2 and 3. As seen from these figures or Table 2 the values of the energy coefficient, α and the momentum coefficient, β increase with increasing values of the friction facor, f and with decreasing values of the Chezy's coefficient, C except for C=20 for the case of α. It may be seen form Table 2 that for lower values of f 0.008 to 0.025 and higher values of C=100 to 300 the quantity, $\left(\frac{\alpha-1}{\beta-1}\right)$ Among the non-exponential velocity distribtuions, the highest values of α and β for higher values of f and smaller values of C are given by Zagustin's law and next smaller values by **Prandtl's** law and the smallest values by **Von-Karman's law. For** smaller values of f and larger values of C, these three laws yield more or less the same values for α and β (Figs. 2 and 3 or Table 2).

4. *CONCLUSION*—:

The widely used Prandtl's logarithmic law of velocity distribution, Von-Karman's law, Zagustin's law and Blassius one-seventh power law, yield almost the same values of the energy and the momentum coefficients in the most commonly encountered regime of turbulent flow at the normal values of the friction factor, f=0.01 to 0.04 (in pipe flow) and the Chezy's co-efficient, C=75 to 100 (in channel flow) Hence, in practice any of these velocity distribution can be used for computing these coefficients

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TABLE I. FLOW CHARACTERISTICS.

STATE OF FLOW		LAMINAR		TURBULENT			TRANSITIONAL	HYPOTHETICAL
FLOW GEOMETRY		PIPE	CHANNEL	PIPE AND CHANNEL				PIPE AND CHANNEL
VELOCITY PROFILE		$u=U-\frac{i}{4\mu}(h-y)^2$	$u=U-\frac{wi}{2\mu}(h-y)^2$	$u=U-\frac{V_*}{k}\ln(\frac{h}{y})$	$u=U+\frac{V_*}{k}\left[(1-\frac{y}{h})^{1/2}+\ln\left\{1-(1-\frac{y}{h})^{1/2}\right\}\right]$	$u=U-\frac{2}{k}\tanh^{-1}(1-\frac{y}{h})^{3/2}$	$u=U(\frac{y}{h})^{1/7}$	$u=U(\frac{y}{h})$
PROPOSER		HAGEN — POISEUILLE		PRANDTL	VON — KARMAN	ZAGUSTIN	BLASIUS	REHBOCK
PIPE FACTOR	PIPE FLOW	$\frac{V}{U}=\frac{1}{2}$		$\frac{V}{U}=\frac{1}{1+1.326f}$	$\frac{V}{U}=\frac{1}{1+1.154f}$	$\frac{V}{U}=\frac{1}{1+1.442f}$	$\frac{V}{U}=\frac{1}{1.22}$	$\frac{V}{U}=\frac{1}{3}$
	CHANNEL FLOW	$\frac{V}{U}=\frac{1}{1.5}$		$\frac{V}{U}=\frac{1}{1+\frac{14.15}{C}}$	$\frac{V}{U}=\frac{1}{1+\frac{11.31}{C}}$	$\frac{V}{U}=\frac{1}{1+\frac{13.11}{C}}$	$\frac{V}{U}=\frac{1}{1.143}$	$\frac{V}{U}=\frac{1}{2}$
PIPE FLOW	α	2		$1+2.962f-1.571f^{1.5}$	$1+2.618f-1.301f^{1.5}$	$1+3.360f-1.061f^{1.5}$	1·050	2·7
	β	1·333		$1+0.976f$	$1+0.874f$	$1+1.127f$	1·020	1·5
CHANNEL FLOW	α	1·543		$1+\frac{600}{C^2}-\frac{5467}{C^3}$	$1+\frac{516}{C^2}-\frac{4917}{C^3}$	$1+\frac{728}{C^2}-\frac{6532}{C^3}$	1·045	5·0
	β	1·200		$1+\frac{200}{C^2}$	$1+\frac{172}{C^2}$	$1+\frac{241}{C^2}$	1·016	2·333

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TABLE 2—ENERGY AND —MOMENTUM CO-EFFICIENTS.

Law for *velocity* Friction Parameters. F	C	Parabolic Law. Pipe flow. α	β	Channel flow. α	β	Prandtl's Law. Pipe flow. α	β	Channel flow. α	β	Von-Karman's Law. Pipe flow. α	β	Channel flow. α	β
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
00·008	10				1	1·022	1·007	1·512	3·000	1·019	1·006	1·242	2·720
0·009	20					1·024	1·008	1·814	1·500	1·022	1·007	1·675	1·430
0·010	30					1·027	1·009	1·463	1·222	1·024	1·008	1·391	1·191
0·015	40					1·040	1·014	1·289	1·125	1·036	1·013	1·245	1·107
0·020	50					1·053	1·019	1·196	1·080	1·048	1·017	1·167	1·068
0·025	60	2	1·333	1·543	1·200	1·066	1·024	1·141	1·055	1·059	1·021	1·120	1·047
0·030	70	..	..	..	..	1·078	1·029	1·106	1·040	1·071	1·026	1·090	1·035
0·035	80	..	..	..	..	1·091	1·034	1·083	1·031	1·082	1·030	1·071	1·026
0·040	90	..	..	..	..	1·103	1·039	1·066	1·024	1·093	1·034	1·056	1·021
·0·45	100	..	..	..	..	1·115	1'043	1·054	1·020	1·104	1·039	1·046	1·017
0·050	150	..	..	..	..	1·127	1·048	1·025	1·008	1·115	1·043	1·021	1·007
0·060	200	..	..	..	..	1·151	1'058	1·014	1·005	1·136	1·052	1·012	1·004
0·070	250	..		..	..	1·174	1·068	1·009	1·003	1·157	1·061	1·007	1·002
0·080	300	..	..	..	..	1·196	1·078	1·006	1·002	1·177	1·069	1·00	1·001

TABLE 2—ENERGY AND MOMENTUM CO-EFFICIENTS—(*contd*).

Zagustin's law. Pipe flow. L	B	Channel flow. L	B	Blassius's law. Pipe flow. L	B	Channel flow. L	B	Rehbock's law. Pipe flow. L	B	Channel flow. L	B
(15)	(16)	(17)	(18)	(19)	(20)	(21)	(22)	(23)	(24)	(25)	(26)
1·025	1·009	1·697	3·410	..	..	..	..	..	..	..	..
1·029	1·010	1·991	1·602	..	..	..	..	..	..	..	..
1·032	1·011	1·561	1·267	..	..	..	..	..	..	..	..
1·047	1·016	1·349	1·150	..	..	..	..	..	..	..	..
1·063	1·022	1·236	1·096	..	..	..	..	..	..	..	..
1·078	1·028	1·170	1·066	1·058	1·020	1·045	1·016	2·700	1·500	5·000	2·333
1·093	1·033	1·128	1·049	..	..	..	..	..	..	..	..
1·107	1·039	1·100	1·037	..	..	..	..	..	..	..	..
1 122	1·045	1·080	1·029	..	..	..	..	..	..	..	..
1·136	1·050	1·065	1·024	..	..	..	..	..	..	..	..
1·151	1·056	1·030	1·010	..	..	..	..	..	..	..	..
1·179	1·067	1·017	1·006	..	..	..	..	..	..	..	..
1·204	1·078	1·011	1·003	..	..	..	..	..	..	..	..
1·234	1·090	1·007	1·002	..	..	..	..	..	..	..	..

Note.—L and B are independent of f and c for Hagen Poiseuilles Law (Parabolic law), Blasius law and Rehbock's law of velocity distribution.

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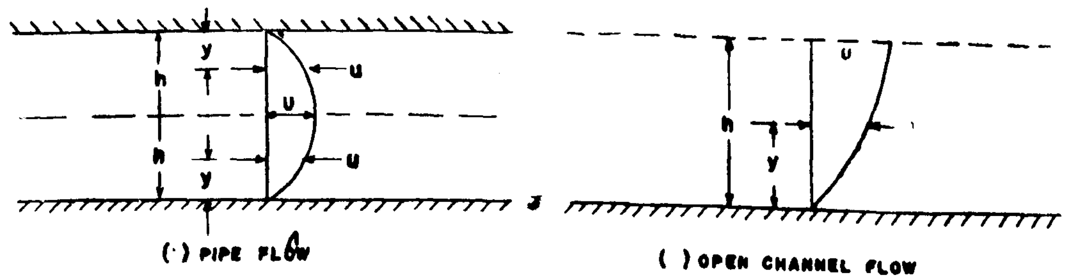

FIG. 1 DEFINITION SKETCH OF VELOCITY DISTRIBUTION

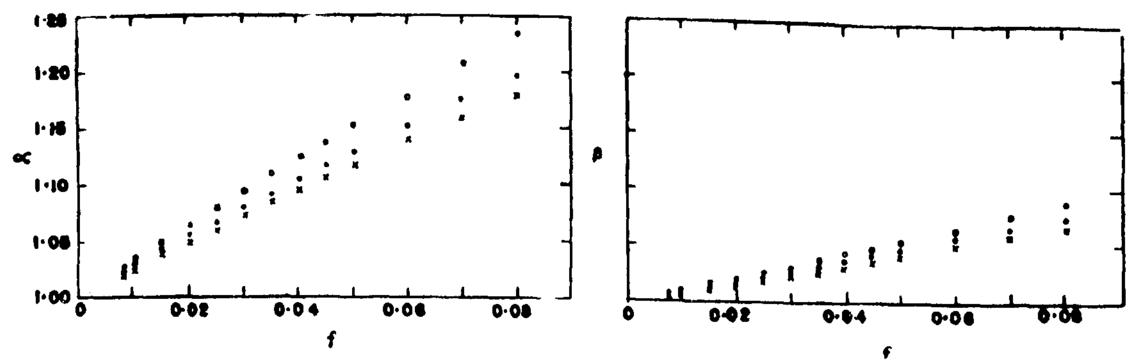

FIG. 2. VARIATION OF α AND β FOR PIPE FLOW

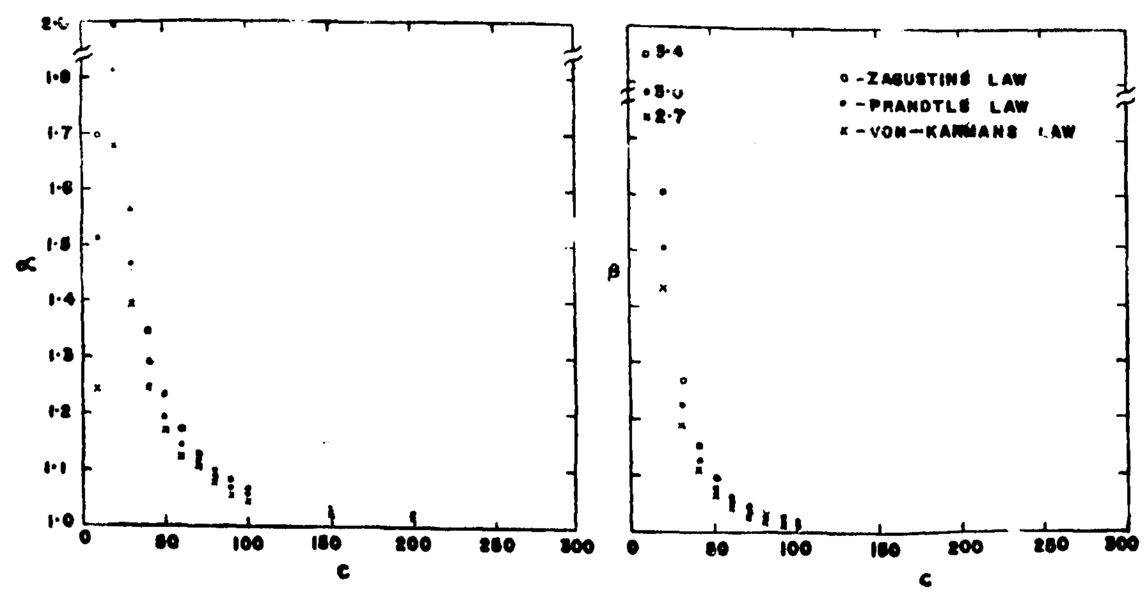

FIG. 3 VARIATION OF α AND β FOR CHANNEL FLOW

TRD.BY.R.N.G

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OUR EDITORIAL BOARD MEMBER GETS NEHRU FELLOWSHIP AWARD

Er. P. Kumaraswamy, B.E. (Hons.), MIAHR, MIASH, MCSI, FCAES (MIT. USA) FASc., MIWRA, is working as Director-in-charge of one of the greatest Engineering Research Station in India (i.e.) Institute of Hydraulics and Hydrology at Poondi Tamil Nadu. He was a very brilliant student even as he was in Engineering College and obtained First Class with Honours in 1951 and he had shown keen interest in knowing the subject thoroughly. He was awarded the Fischer's Gold Medal of the University of Madras for proficiency in Mathematics. After completing his studies he has joined in Public Works Department, Tamil Nadu as Junior Engineer in Irrigation Research Station, Poondi in 1951 and he became Assistant Engineer by Direct recruitment in the year 1955. As Assistant Engineer he has worked in many Irrigation Projects in Tamil Nadu both in investigation and execution and also as Assistant Research Officer, Irrigation Research Station, Poondi. He has also served as Executive Engineer in Tuticorin Harbour Projects, High Pressure Boiler Plant Project, Tiruchirappalli, Design and Construction Branch of Industries Department, etc. By working hard he has brought credit not only to the Project where he worked but also to the Government. During his tenure as Assistant Research Officer in the Hydraulic Station, Poondi he has developed keen interest in Hydraulic Research. In 1967 Government appointed him as Executive Engineer, P.W.D., Hydraulic Research Station, Poondi. Only during this period he has improved the Research Station as a full-fledged Institution for conducting Hydraulic and Hydrology Research and from the date of upgrading of the Institution he is looking after the Research Station as acting Director.

During this period Government of India after seeing his aptitude for Research awarded him the Homi Bhaba Fellowships and sent him abroad for conducting further research in Hydraulics, in recognition of his work on "Electronic Analogue Computer" to assess the ground water potential a method also useful in oil mining. He has done research work for this fellowship in the Tata Institute of Fundamental Research in Bombay and in Massachusettes Institute of Technology, U.S.A.

Once again the Government of India have awarded the Nehru fellowship to him in 1974. It carries a sum of Rs. 3,000 p.m. as Honorarium and a consolidated amount of Rs. 10,000 per year for maintenance of Office equipment, etc. This is for a period of 2 years.

He has selected to do the Research in the same Institute even though he can do the same anywhere in the world.

The main aim of his present study under the Fellowship is to scientificially fore cast the run off based on the already collected information on ground water potential rainfall surface vegitation, etc. This will give more realistic and reliable result than the present run off formulae. This method will help the Irrigation and Water Management Engineer in a big way.

At present he is one of the Member in Editorial Board in the Publication of this Irrigation Era and also he is the only Engineer working in this Department who has been selected for this Fellowship till now.

We wish him great success in his Research and also many more larels in recognition of his Research work.

EXTRACT FROM SPECTRUM—BRITISH SCIENCE NEWS

NEW TECHNIQEES FOR FLOOD ESTIMA-TION.

By

CELIA KIRBY

Institute of Hydrology, Wallıng ford, Oxfordshire.

Loss of Life and property through flooding is a common hazard the world over because when and where floods will occur is very difficult to forecast. New techniques are now available for estimating the expectation of floods of various magnitudes for any given site and will be an important tool for civil engineering design in the future.

Despite its small size, the UK is sixth in the world league in the number of reservoir dams it has (first is China, followed by the USA, Japan, India and Spain). This is because most of its rain falls in places where there are few people so that complex storage facilities are needed to get and hold enough water. This situation is not unique to the UK. however, and British Civil Engineers aroften called upon to use their expertise in dam building all over the wotld.

Common to all structures built to contain of divert water, wherever they are sited is the ability to srand up to stressess of flooding hrought about by erratic weathe, chahges. Because no-one can yet predict future weather conditions, all engineers have to build-in big safety maygins when deciding on the final size of a structure, to allow fot what is known as the design maximum storm.

Basically, floods happen in two ways. Firstly, there is flash flooding, when sudden heavy rain falls on impermeable or saturated soil or, in urban situations, when the volume of rain water is too great to run off through gutters and sewers. Secondly the river may flood by overtopping its banks because of too much water coming in from the streams in its catchment area. Improved weather forecasting through better monitoring of global weather condi. tions may give us earlier warning of potential flood situations but without better knokledge of the river regime at a particular site the extent of the danger cannot be estimated.

PAST RECORDS.

Ways of estimating flood risks, including possible maximums and how often they might occur at any particular site, are based on studying the previous behaviour at that site. Past records of the flood levels in the streams and rivers of the area are related to the known rainfall for that period. The weakness in method lies in the assumption that the physical nature of the area has remained unchanged-no towns built or no extensive forest development to upset soil drainage patterns--and that reliable records exist for the site in question. This is by no means always the case even in countries with mandatory requiremenents for hydrological records so such information is likely to be scarce in many areas of the world.

Now, a comprehensive survey into the magnitude and frequency of floods in the UK has produced not only an improvement in the existing flood risks at sites for which no records exist. Supported as it was as a special recearch project of the Institute of Hydrology, at Wollingford. the study was bassed on UK. records, supplemented with those from the Irish Repnblic thus considering the British Isles as a geographical entity uncomplicated by political boundaries). However, to argue the case for their proposed methods the team yroducing the lengthy report have included in it a thorough appraisal of all the proven statistical techniquss for this type of work. This makes the report a valuable text-book for other researchers and aiso contains much that can be applied in other regions of the world with similar climate and topography. Indeed, in countries where floods are mere seasonal, the procedure could work even better than they do for the UK situation.

STATISTICS :

The report puts forward two ways of estimating floods. depending on the kind of design informtion the engineer needs. The first comes from a statistical study of past floods, using the records of 500 different flood gauging stations to try and assess the important factors that contribute to flooding. It is clear that catchment topograthy such as area, slope, channel network and type of soil, all influence the way any particular area reasons to rainfall input in terms of the extent of the flood that rain produces. Area, slope and type of soil (classified here according to winter rain acceptance rate, which is a good indicator of filtering potential) are fairly easy to obtain, but drainage density is difficult to measure as it requires working out the total channel length and then dividing this by the catchment area. However, it seems that there is a high correlation between drainage density and what is known as stream frequency. This is the number of channel junctions and is a feature that does appear reliably on large scale maps.

The stream frequency factor is produced by adding up the number of natural stream junctions, counting upstream from the lowest site and tuen dividing this nnmber by the catchment area. Artificial channels cut for drainage and canals are ignored for that exercise.

By looking at past flood events, formulae have been derived to give the maximum possible flood produced from any given rainfall input by feeding in information of the topography of the area, suitably weighted, mathematically speaking, according to its importance in affecting runoff generation. The beauty of this method is that much of the information needed can be gained from reasonable large-scale maps and thus eliminates the need for actual records.

The second apporach is applicable for situation where the engineer needs a detailed pictures of the kind of flood likely to be produced. For instance, for designing reservoir spillways he needs to know not just the peak flow to be encountered during any storm but also the way the flow is likely to build up and go down. The technique known as the 'unit hydrograph' came in useful here. This assumes that for a given drainage basin or catchment there is a constant response to a unit of effective rainfall (that is, the amount of rain left to generate runoff after the soil has been saturated, some has been lost by evaporation, and so on).

When the research team looked at past records of flooding for which there were also corresponding hourly rainfall records, they found that percentage runoff could actually be predicted from the physical condition of the catchment at the time, taking account of such factors as soil type, state of catchment wetness and land use. In practical terms, if details of the catchment are fed into appropriate equations measurements of area, stream length, angle of slope, urban percentage) together with rainfall the answer will come up about how long the flood will take to reach its worst and how long it will last. This answer is then modified according to catchment wetness and percentage runoff indices to given a complete picture of the flood likely to by produced by anp given rainfall input. This is a long but by no means difficult operation for the design engineer.

TABLES :

A crucial factor in flood estimation is, of course the rainfall input. The Meteorological Office produced maps and tables from which to estimate the amount of rain to be expected in any location in any period and with any rarity up to the 'estimated maximum'. Again, like the flow records, the work was based on UK data but the methods used and the application in flood estimation techniques can be used in wider context. Using this information it is possible to say how big a flood will occur at a partioular site following a given rainstorm and to say how often there will be a flood. This is important when dealing with the problem of relating costs of flood control schemes to areas of flood risk.

No one has yet found a way of accurately predicting weather conditions for more than a few hours ahead. Until that time, we can only build to withstand probable hazards and try to minimize the damage flooding causes. The design of structures can be refined by using flood estimation procedures but this work also has another vital application. It is particularly valuable to people trying to plan the use of land. Many of the dangers and economic hardships of flooding could be avoided if man conceded victory to the elements by not trying to develop flood plains the low-lying land used as natural extension to the river channel during periods of high flow. In many parts of the world however (and certainly in the UK) urbanization has already claimed the major flood plains. Attempts are made to stop the water from overflowing the banks, by better management of rivers and by providing special embankments and culverts to retain or divert the water so that it does no harm. Improved flood estimation does at least give the engineer a clearer idea of the potential risks, so he can plan accordingly.

*Flood Studies Report: 5 vols., Published by the Natural Environment Research Council, price £ 40·00.

பிரதமரின் இருபது அம்சத் திட்டம்

1. இன்றியமையாப் பண்டங்கள் விலையைக் குறைத்திட வேகமான முயற்சிகள், உற்பத்தி உயர்வு, பண்டக்கொள்முதல் அலுவலை விரைந்து நடத்துவது, இன்றியமையாப்பண்டங்கள் வழங்குமுறையைச் சீராக்குவது.
2. விவசாய நில உச்சவரம்புச் சட்டத்தை அமல் நடத்துவது, உபரி நிலத்தை நிலமற்ற வர்களுக்கு விரைவாகப் பகிர்ந்தளிப்பது.
3. நிலமற்றவர்களுக்கும் ஏழை மக்களுக்கும் வீட்டு மனை.
4. அடிமை முறை ஒழிப்பு.
5. கிராம மக்களின் கடன் தொல்லையை நீக்குவது.
6. விவசாயத் தொழிலாளர்களுக்கான குறைந்த பட்ச ஊதிய விகிதத்தைத் திருத்தி யமைப்பது, தேவைப்பட்டால் அந்த ஊதிய விகிதத்தை உயர்த்துவது.
7. கூடுதலாக 50 லட்சம் ஹெக்டேர் நிலப்பரப்புக்குப் பாசன வசதி அளிப்பது.
8. மேலும் 2,600 மெகாவாட் மின்சக்தி உற்பத்தி.
9. கைத்தறித் தொழிலுக்குத் தனி உதவி, நெசவாளர்களுக்குத் தொழில் பாதுகாப்பு.
10. சாதாரண மனிதனுக்குத் தரமான துணி, வகைகளைச் சிறந்த முறையில் வழங்குவது.
11. நகர்ப்புற நிலங்களையும் நகரங்களைச் சுற்றியுள்ள நிலங்களையும் எல்லோருக்கும் பகிர்ந்து கொடுப்பது, காலியான நிலங்களை ஏராளமாகச் சேர்த்து வைத்துக் கொள்வதற்கு உச்சவரம்பு, புதிய குடியிருப்புப் பகுதி நிலமனைக்கு உச்சவரம்பு.
12. வரி ஏய்ப்புத் தடுப்பு, பொருளாதாரக் குற்றங்கள் சம்பந்தமாக உடனடி விசாரணை, இத்தகைய குற்றம் புரிபவர்களுக்கு கடுமையான தண்டனை.
13. கடத்தல்காரர்களின் சொத்துக்களைப் பறிமுதல் செய்வதற்குத் தனிச் சட்டம்.
14. தொழில் மூலதனத்திற்கு நெறிமுறைகளைத் தளர்த்துவது, இறக்குமதி லைசென்சுகளைத் தவறாகப் பயன்படுத்துவோர்மீது தகுந்த நடவடிக்கை.
15. தொழில் நிர்வாகத்தில் தொழிலாளர்கள் மேலும் சிறந்த முறையில் பங்கு கொள்வதற்குப் புதிய திட்டங்கள்.
16. சரக்குகளை டிரக்குகளில் ஏற்றி சாலை மூலம் எடுத்துச் செல்வதில் உள்ள முட்டுக் கட்டைகளை நீக்குவது—தேசிய பெர்மிட் முறை கொண்டுவரப்படவிருக்கிறது.
17. 8,000 ரூபாய் வரை வருமான வரி விலக்கு.
18. மாணவர் விடுதிகளுக்கு நியாய விலைக்கு இன்றியமையாப் பண்டங்கள் வழங்குதல்.
19. மாணவர்களுக்கு நியாய விலைக்கு பாடப் புத்தகங்கள், எழுது பொருள்கள் முதலிய வற்றை வழங்குதல்.
20. மக்களுக்கு, குறிப்பாக வசதி குறைந்தவர்களுக்கு வேலை வாய்ப்புக்களையும் பயிற்சி வாய்ப்புகளையும் அதிகமாக்கிடப் புதிய தொழிற்பயிற்சித் திட்டங்கள்.

INVITATION TO READERS.

Kind attention of the Engineers of the Tamil Nadu Public Works Department and readers of the journal elsewhere is drawn to the meagre response to repeated requests for contribution of articles to the journal.

May we once again emphasise the two-fold objective of the journal, viz., to promote the interest of engineers and aiding their specialised work by placing before them the many problems of technical importance and ways and means of solving them, and secondly, opportunities being scarce for engineers to express their own experience in solving practical problems of design and execution, we wish to add that this journal has been the only medium of expression for those in the field. It is earnestly desired that the Engineering fraternity will come forward in large numbers to utilise this medium to its best advantage by offering their valuable contribution.

The scope of the articles to the journal need not be rigorously confined to the subjects on Irrigation alone. Articles which have a direct bearing on subjects given below are also welcome :—

(1) Technical aspects of foundation soils and foundation Engineering.

(2) Auxiliary works in the field of Irrigation and other water-retaining structures and works.

(3) Practical solution to hydraulic problems in Canals and distribution systems with reference to their maintenance.

(4) Problems of soil erosion and conservation and reclamation of land.

(5) Practical silt problems in rivers and reservoirs.

(6) Problems of sanitation and public health and possibilities of utilisation of sewage.

(7) Inland waterways and navigation, fishing schemes and protection of land against sea erosion, etc.

(8) Problems of drainage in deltaic tracts and entrance of rivers into the sea.

(9) Run-off studies in catchments and evaporation studies in reservoirs.

(10) All allied subjects.

The Executive Engineers of the Tamil Nadu Public Works Department are specially requested to encourage their subordinate officers to come forward with articles and enable the journal to flourish and serve the common cause of the Engineers of the State.

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