$\bar{A}_{ox_f}$ is the average area for the whole sample at the end of the test.

$$\text{i.e.} \qquad \left[\begin{aligned} L &= \left\{R_i S_{ox_i} x_i^{m_i+3} - R_f S_{ox_f} x_f^{m_f+3}\right\} \\ &= E(\sigma_i - \sigma_f)^{\mu} \end{aligned}\right]$$

This is a general relationship for the change in overall specific surface area of a sand due to particle migration. Numerical values can be obtained for all the quantities in this relationship.

The values of the constants E and μ have been estimated by calculating the equation of the line of best fit to the Particle Migration Function - Area of Hysteresis Loop correlation. The equation to this line is:

$$L = 21.8(\sigma_i - \sigma_f)^{1.26}$$

The correlation coefficient in this case is 0.785 which indicates a high degree of linear correlation.

Combining this with the equation:

$$L = A_{ox_i} - \bar{A}_{ox_f}$$

i.e.

$$L = 98.(S_i^{-0.47} - S_f^{-0.47})$$

We obtain:

$$L = 98.(S_i^{-0.47} - S_f^{-0.47}) = 21.8(\sigma_i - \sigma_f)^{1.26}$$

OR:

$$\frac{(\sigma_i - \sigma_f)^{1.26}}{(S_i^{-0.47} - S_f^{-0.47})} = 4.5$$

This represents the general relationship for the change in Specific Surface Area of a filter sand due to Particle Migration.

This relationship is a very interesting one as it relates the specific surface area of a soil directly to the soil density, hydraulic gradient and quantity of flow. Not only this, but the correlation is made via the grading curves of the soils. This shows once more what an important influence the particle size disbribution of a cohesionless soil has on the general behaviour of that soil.

PERMEABILITY-TIME RELATIONSHIPS

The change of the permeability of filter sands with respect to time immediately after the commencement of flow has provided an interesting study in this thesis. As the factor of air segregation in the sample voids was practically eliminated by the careful de-airing precautions, the only factors of importance which could have influenced the permeability of the sand samples were those of Particle Migration and the compression of the voids of the sand caused by slippage between the sand grains due to the seepage forces. The combination of these two factors had a large influence on the permeability not only of those sands which underwent

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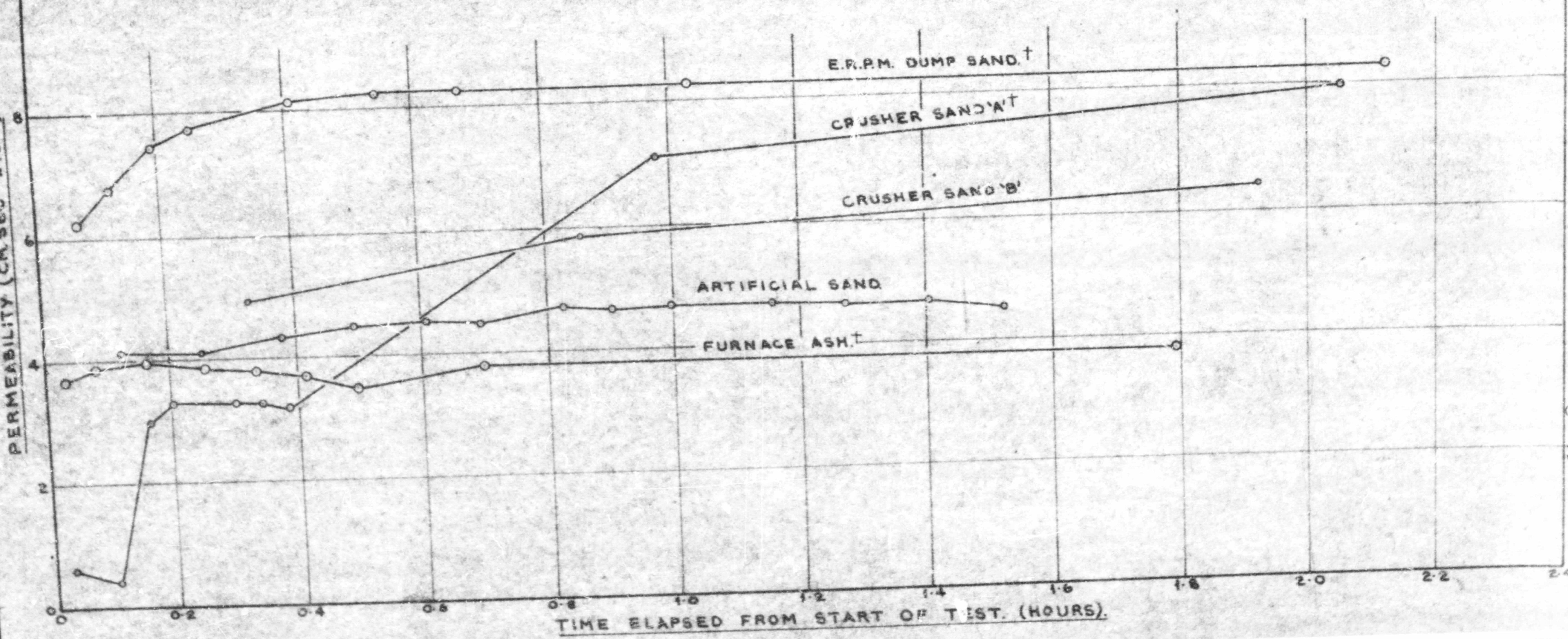
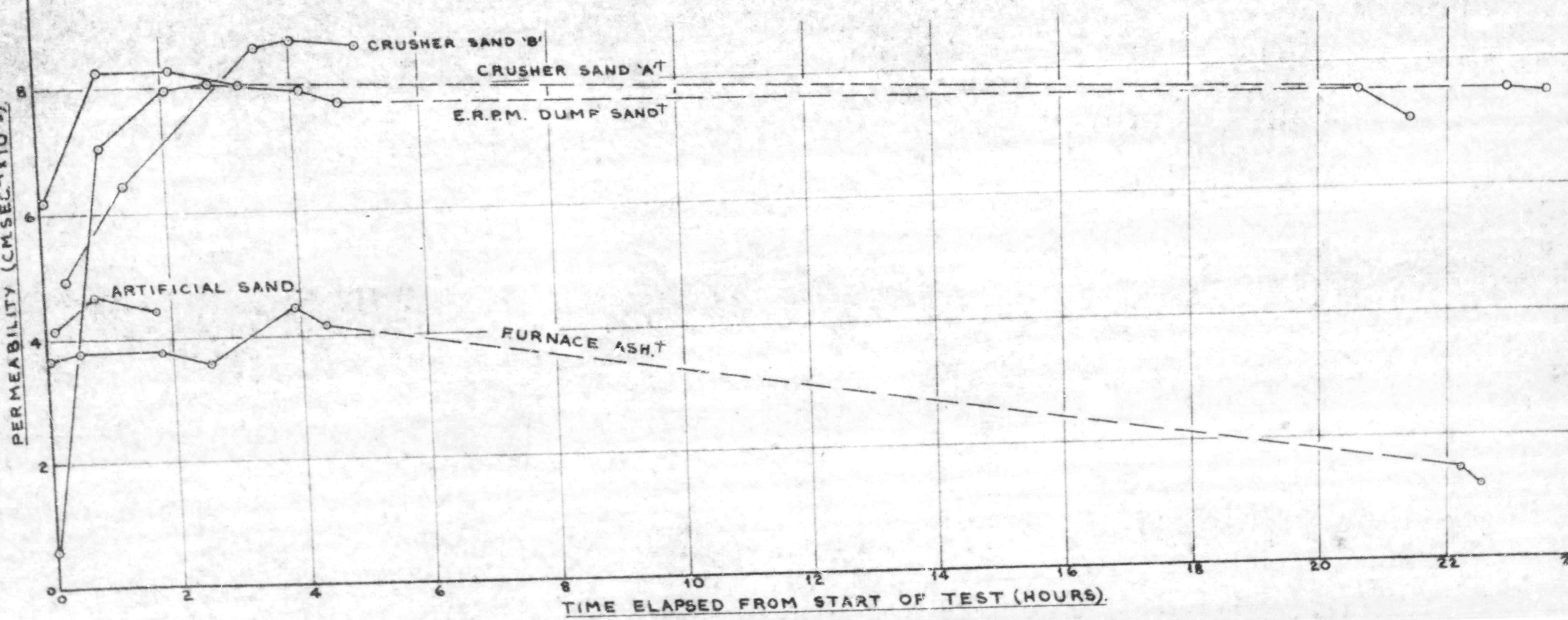
PERMEABILITY-TIME CURVES FOR SANDS WITH UNSTABLE GRADINGS.

THESE CURVES SHOW TYPICAL VARIATIONS IN PERMEABILITY FOR THE FIRST 2 HOURS OF FLOW THROUGH SEVERAL FRESHLY PLACED SANDS. SANDS MARKED † UNDERWENT EXTENSIVE CHANGES OF GRADING.



PERMEABILITY-TIME CURVES FOR SANDS WITH UNSTABLE GRADINGS.

THESE CURVES SHOW TYPICAL VARIATIONS IN PERMEABILITY FOR THE FIRST 24 HOURS OF FLOW THROUGH SEVERAL FRESHLY PLACED SANDS. SANDS MARKED† UNDERWENT EXTENSIVE CHANGES OF GRADING. THE DOTTED PORTIONS OF THE CURVES REPRESENT THE NIGHT HOURS DURING WHICH NO READINGS WERE TAKEN.



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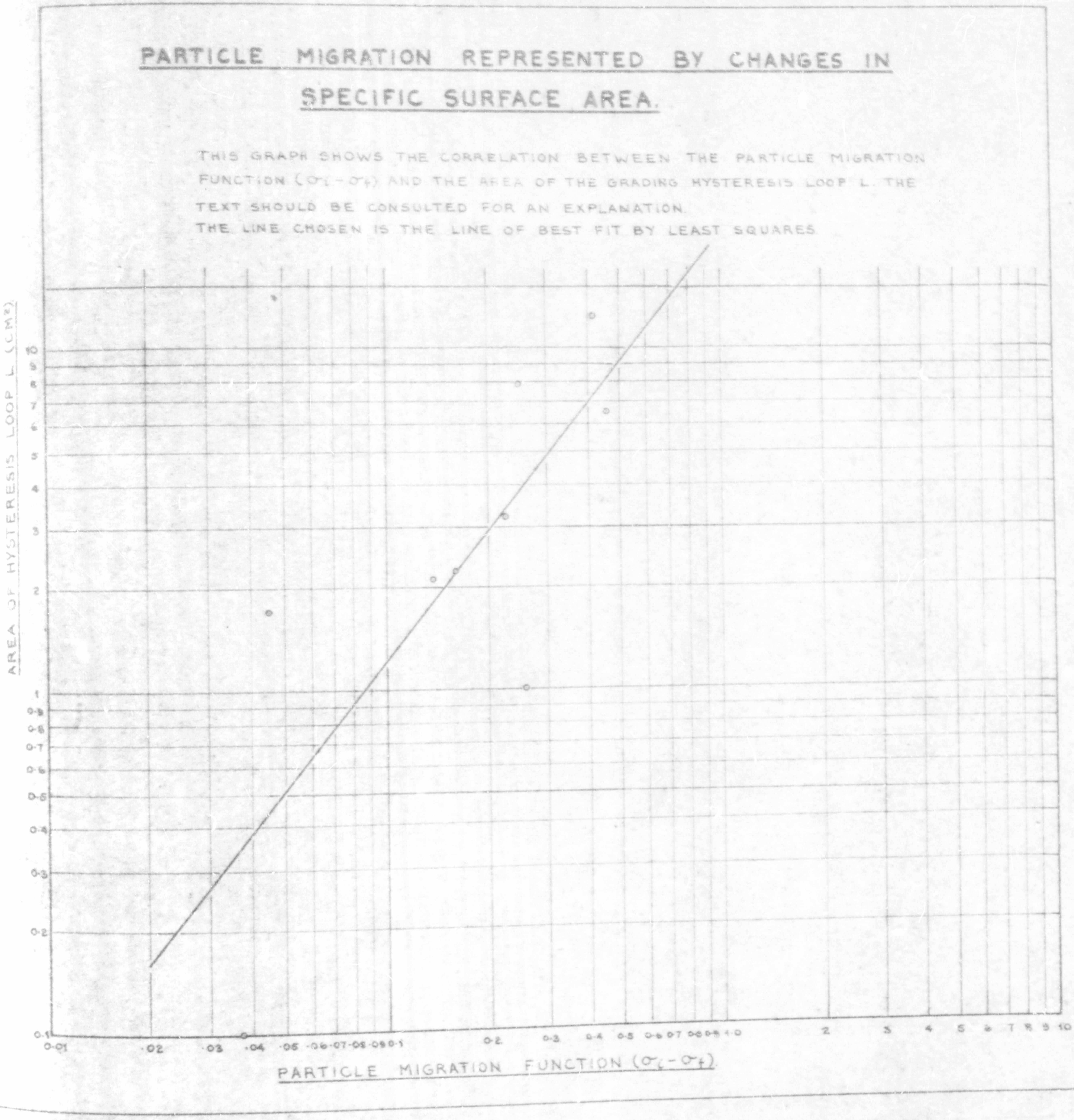
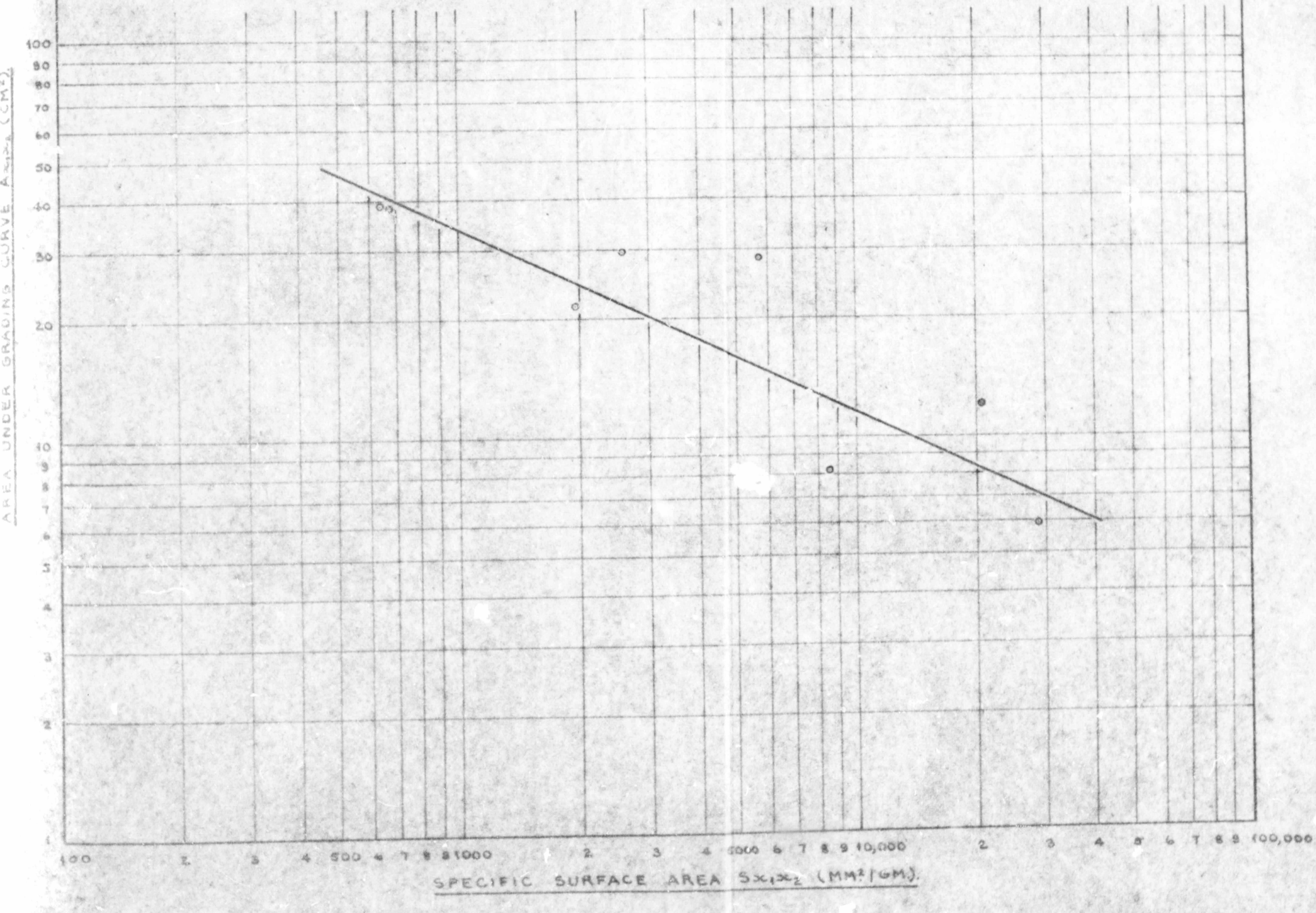
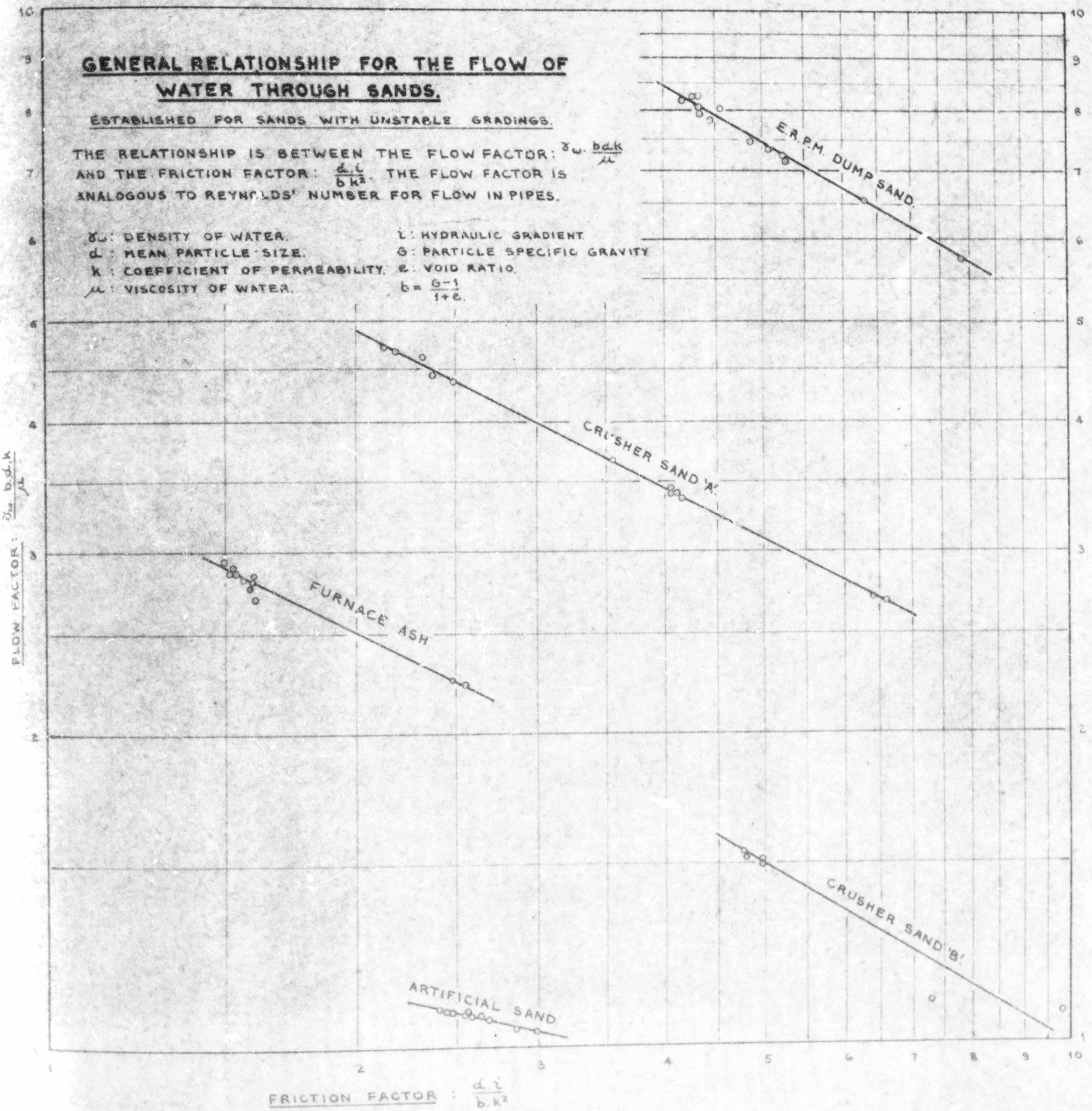
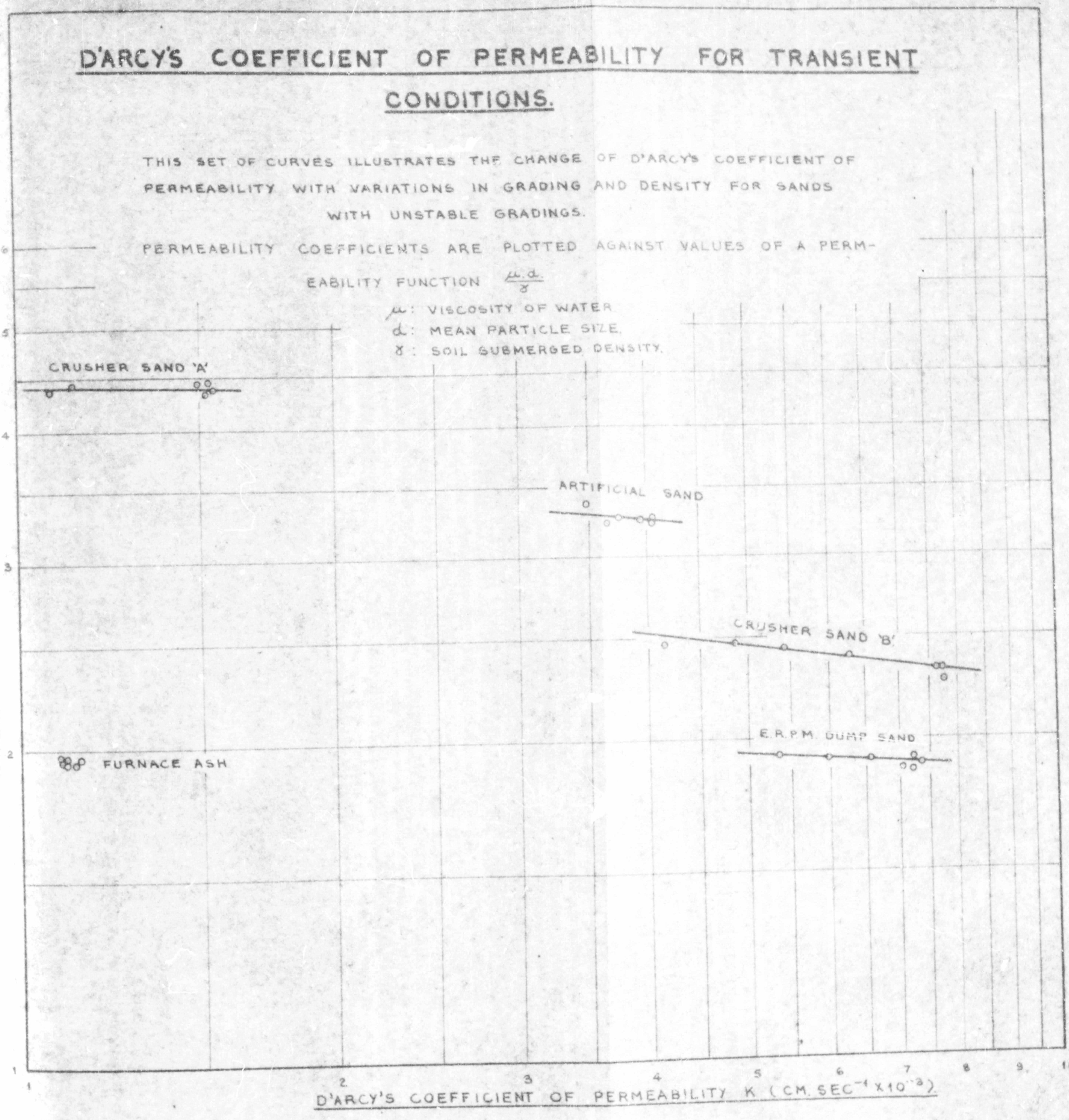

PARTICLE MIGRATION REPRESENTED BY CHANGES IN SPECIFIC SURFACE AREA.
THIS GRAPH SHOWS THE CORRELATION BETWEEN THE PARTICLE MIGRATION FUNCTION ($\sigma_i - \sigma_f$) AND THE AREA OF THE GRADING HYSTERESIS LOOP L. THE TEXT SHOULD BE CONSULTED FOR AN EXPLANATION.
THE LINE CHOSEN IS THE LINE OF BEST FIT BY LEAST SQUARES.
AREA OF HYSTERESIS LOOP L (CM²)
PARTICLE MIGRATION FUNCTION ($\sigma_i - \sigma_f$)

THE CORRELATION BETWEEN THE SPECIFIC SURFACE AREA AND THE AREA BENEATH THE GRADING CURVE OF A SAND.

THIS SHOWS A LINEAR RELATION ON A LOGARITHMIC BASIS BETWEEN THE SPECIFIC SURFACE AREA OF A SAND AND THE AREA BENEATH ITS CUMULATIVE SEMI-LOGARITHMIC GRADING CURVE.
THE LINE CHOSEN IS THE LINE OF BEST FIT BY LEAST SQUARES.




GENERAL RELATIONSHIP FOR THE FLOW OF WATER THROUGH SANDS.
ESTABLISHED FOR SANDS WITH UNSTABLE GRADINGS.
THE RELATIONSHIP IS BETWEEN THE FLOW FACTOR: $\gamma_\omega \cdot \frac{b d k}{\mu}$ AND THE FRICTION FACTOR: $\frac{d \cdot i}{b k^2}$. THE FLOW FACTOR IS ANALOGOUS TO REYNOLDS' NUMBER FOR FLOW IN PIPES.
γ_ω : DENSITY OF WATER.
d : MEAN PARTICLE SIZE.
k : COEFFICIENT OF PERMEABILITY.
μ : VISCOSITY OF WATER.
i : HYDRAULIC GRADIENT.
G : PARTICLE SPECIFIC GRAVITY.
e : VOID RATIO.
$b = \frac{G-1}{1+e}$.
E.R.P.M. DUMP SAND.
CRUSHER SAND 'A'.
FURNACE ASH
CRUSHER SAND 'B'.
ARTIFICIAL SAND
FLOW FACTOR: $\frac{\gamma_\omega \, b \cdot d \cdot k}{\mu}$
FRICTION FACTOR : $\frac{d \cdot i}{b \cdot k^2}$


D'ARCY'S COEFFICIENT OF PERMEABILITY FOR TRANSIENT CONDITIONS.
THIS SET OF CURVES ILLUSTRATES THE CHANGE OF D'ARCY'S COEFFICIENT OF PERMEABILITY WITH VARIATIONS IN GRADING AND DENSITY FOR SANDS WITH UNSTABLE GRADINGS.
PERMEABILITY COEFFICIENTS ARE PLOTTED AGAINST VALUES OF A PERMEABILITY FUNCTION $\frac{\mu . d}{\gamma}$
μ : VISCOSITY OF WATER
d : MEAN PARTICLE SIZE.
γ : SOIL SUBMERGED DENSITY.
CRUSHER SAND 'A'
ARTIFICIAL SAND
CRUSHER SAND 'B'
E.R.P.M. DUMP SAND
FURNACE ASH
PERMEABILITY FUNCTION $\frac{\mu d}{\gamma}$
1
2
3
4
5
6
7
8
9
10
D'ARCY'S COEFFICIENT OF PERMEABILITY K (CM. SEC^{-1} X 10^{-3})