Dredging A Way Of Life

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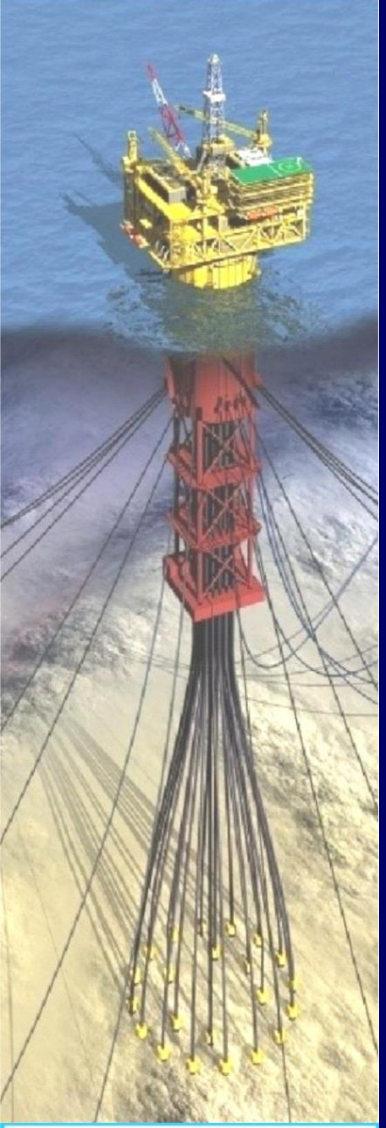

Offshore & Dredging Engineering

Dr.ir. Sape A. Miedema
Educational Director/Head of Studies:
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THE DELFT SAND, CLAY & ROCK CUTTING MODEL

Problem definition: In 30 years many papers, a lot of redundancy, but what are the main issues.

Solution: Writing a book showing the main issues.

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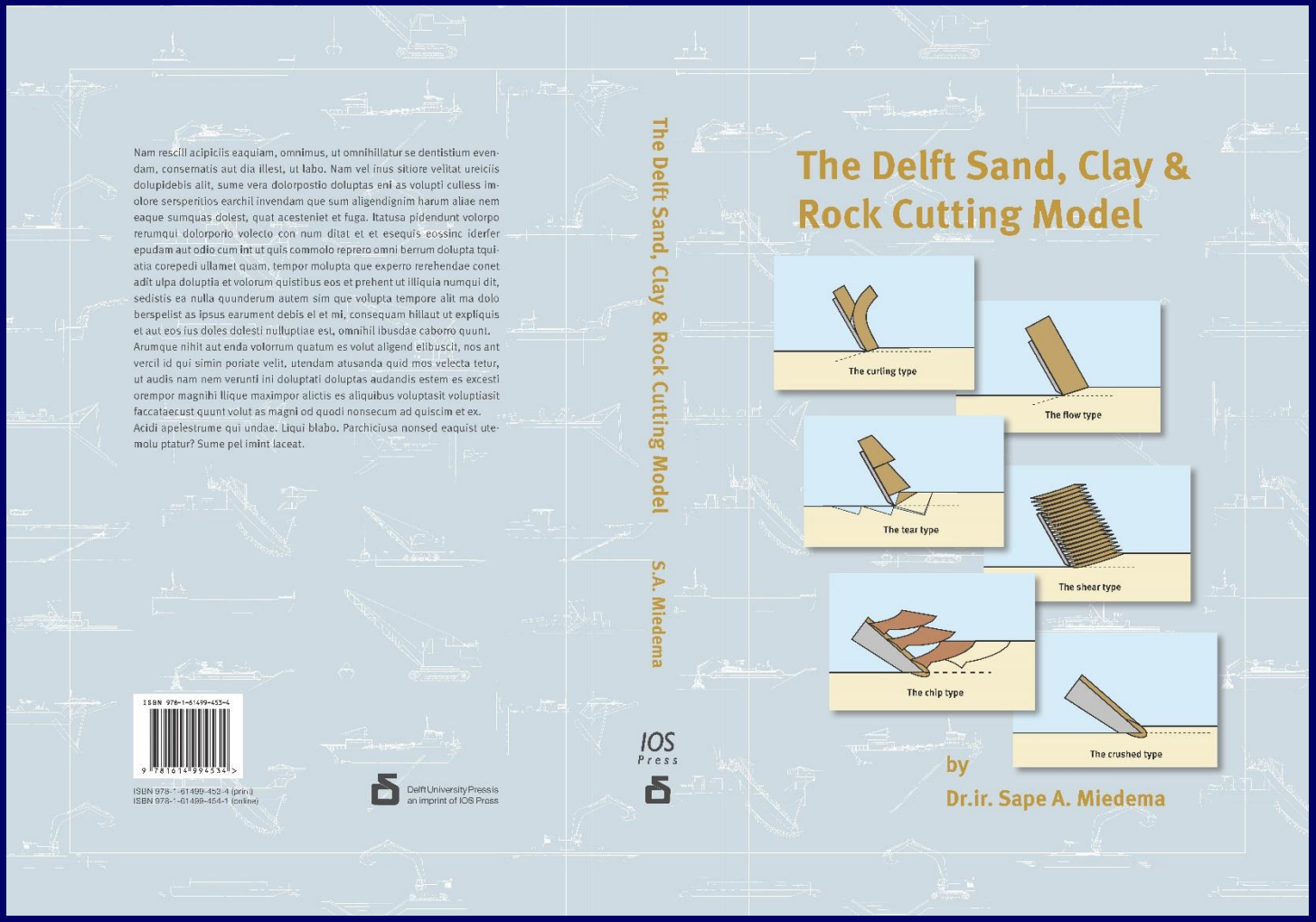
THE DELFT SAND, CLAY & ROCK CUTTING MODEL



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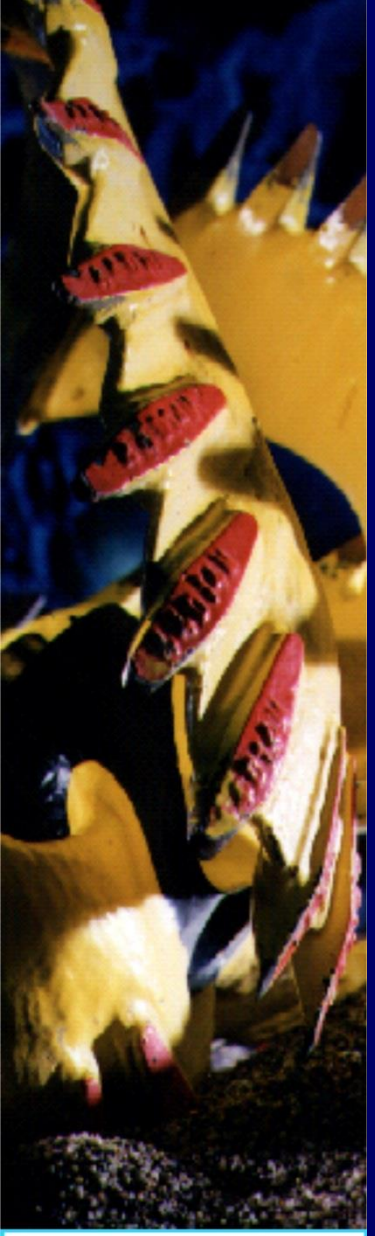

Cutting Experiments

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Hatamura Chijiiwa Test Facility

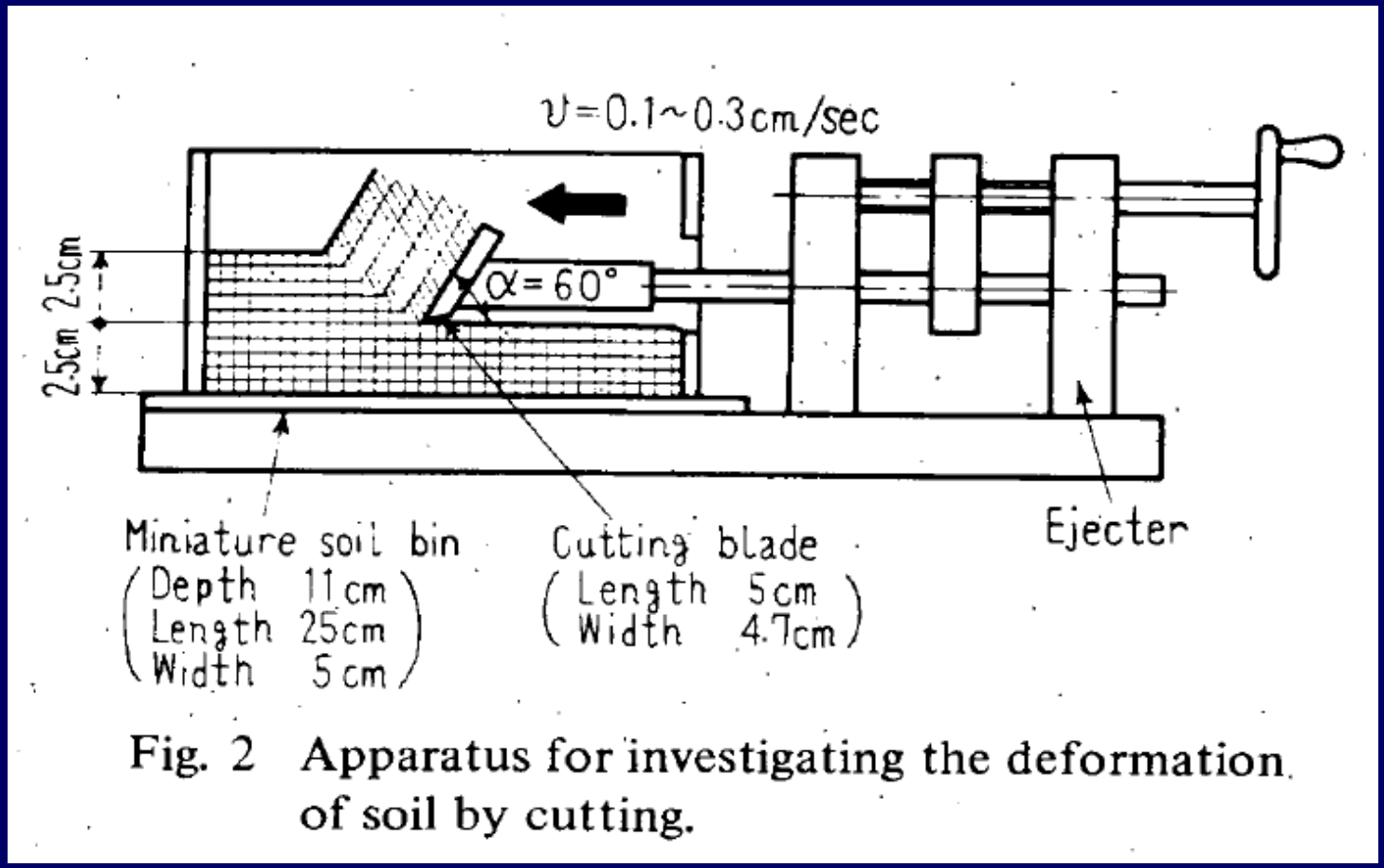
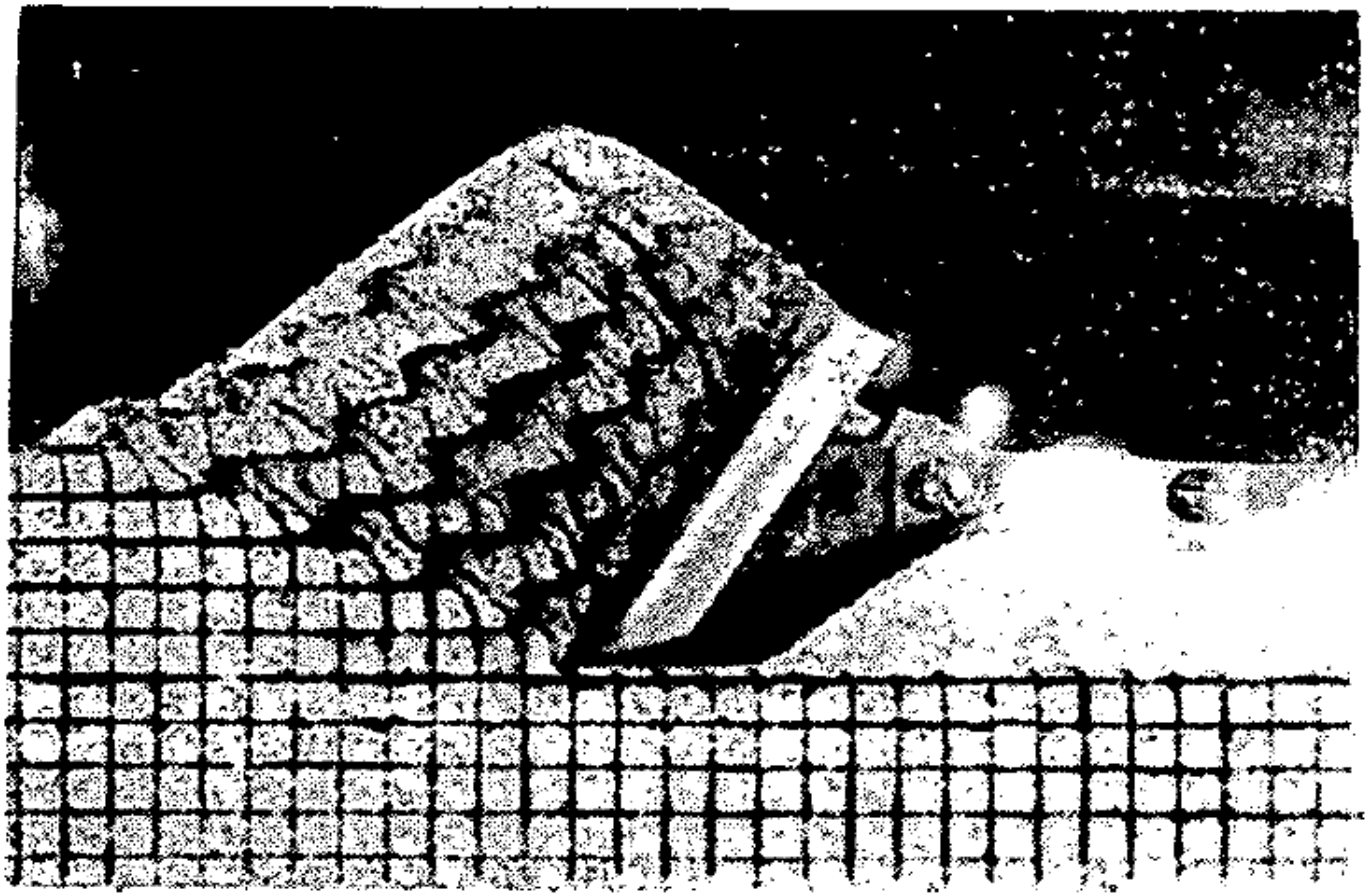


Fig. 2 Apparatus for investigating the deformation of soil by cutting.

Hatamura Chijiiwa Dry Quarts Sand



(a) Dry quartz sand

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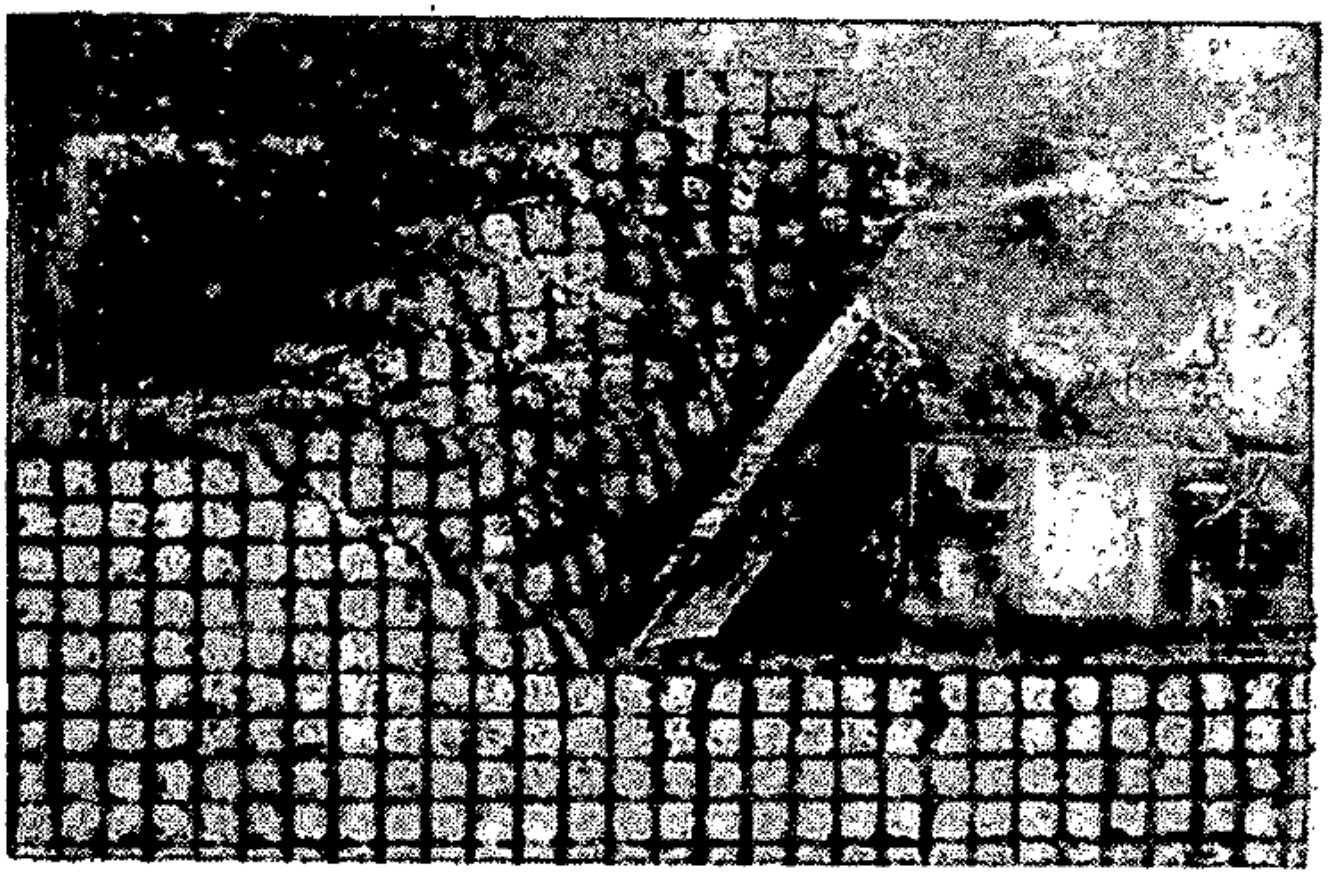
Hatamura Chijiiwa Wet Quarts Sand



(b) Wet quartz sand

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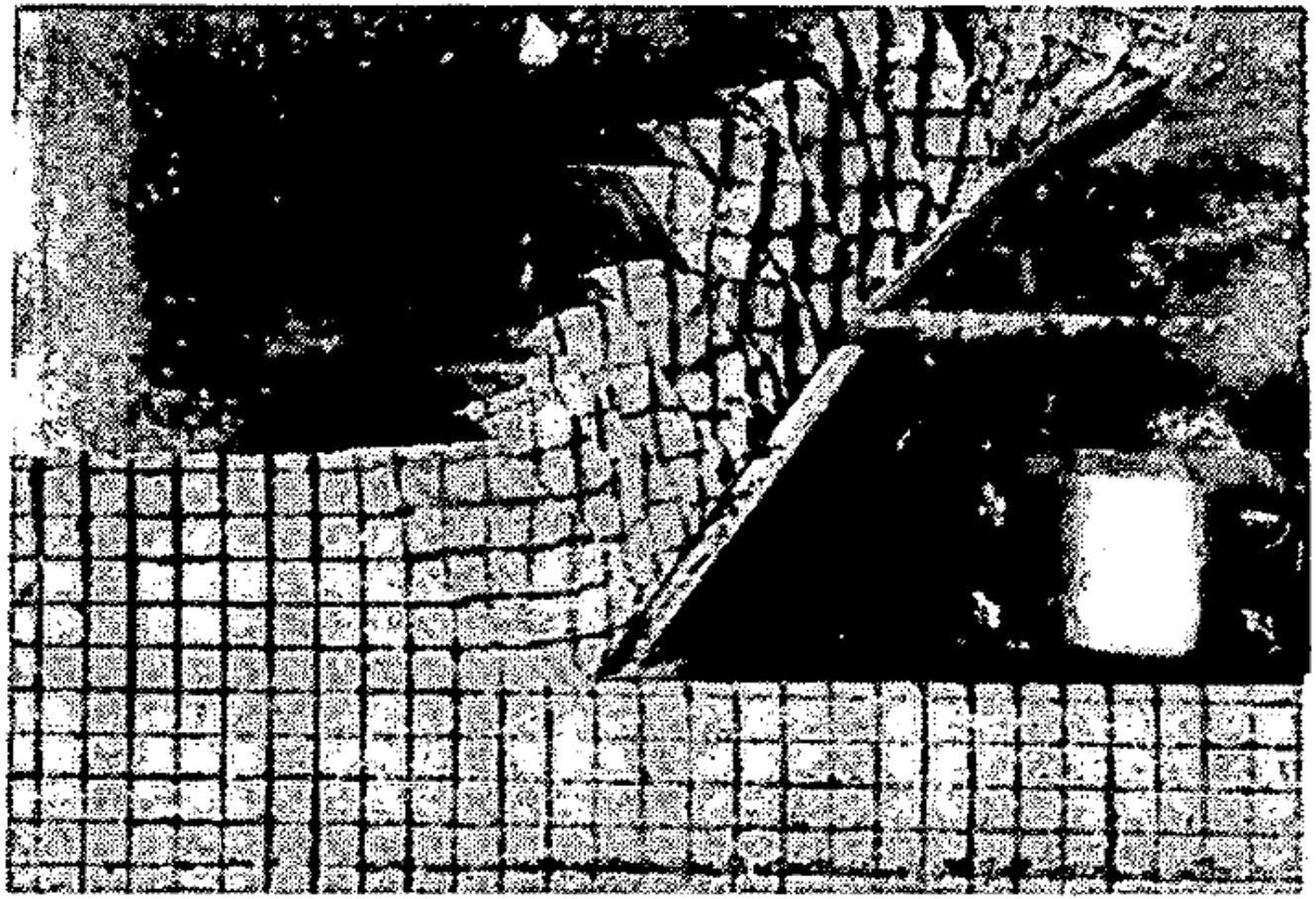
Hatamura Chijiiwa Plastic Bentonite



(c) Plastic bentonite

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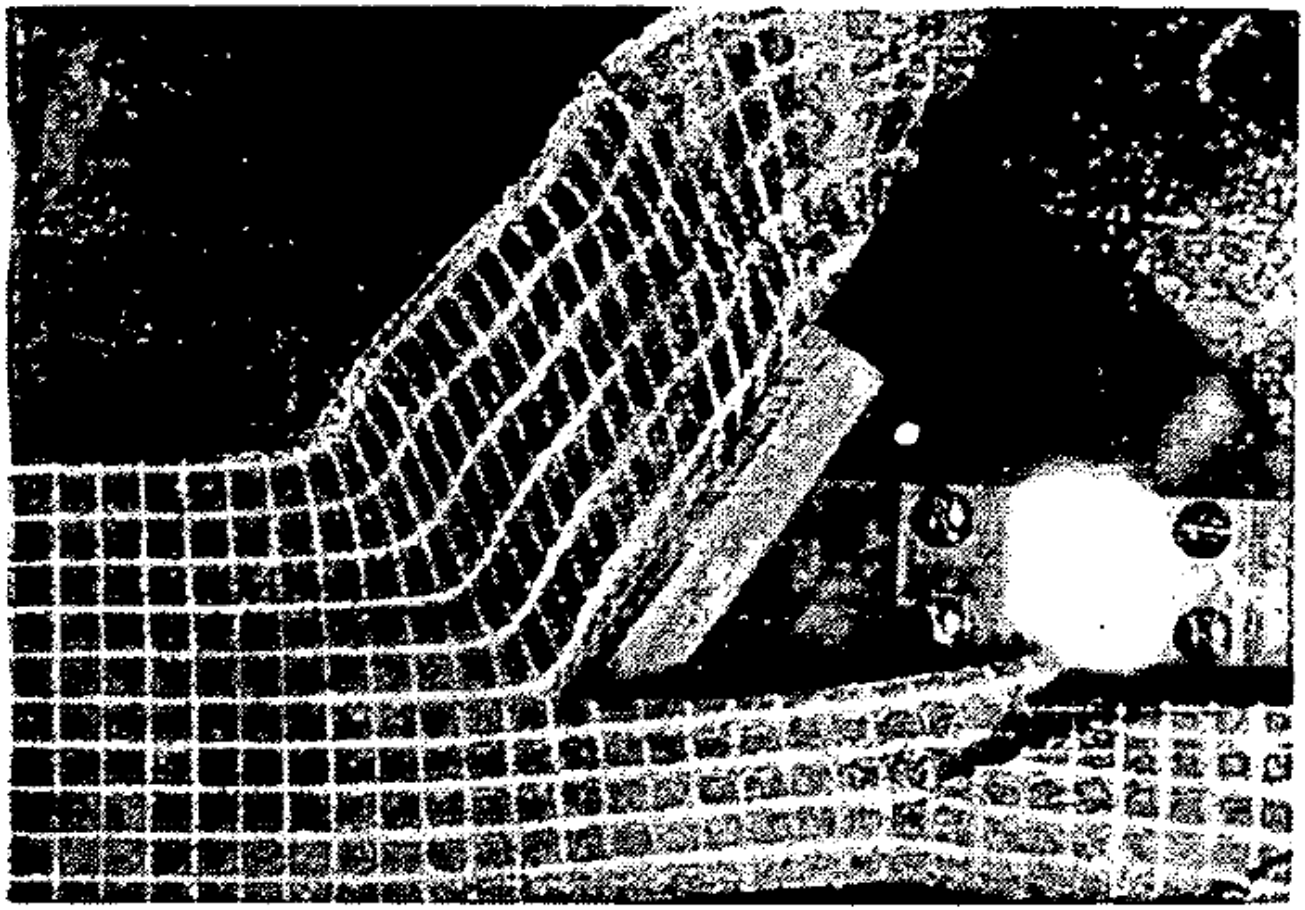
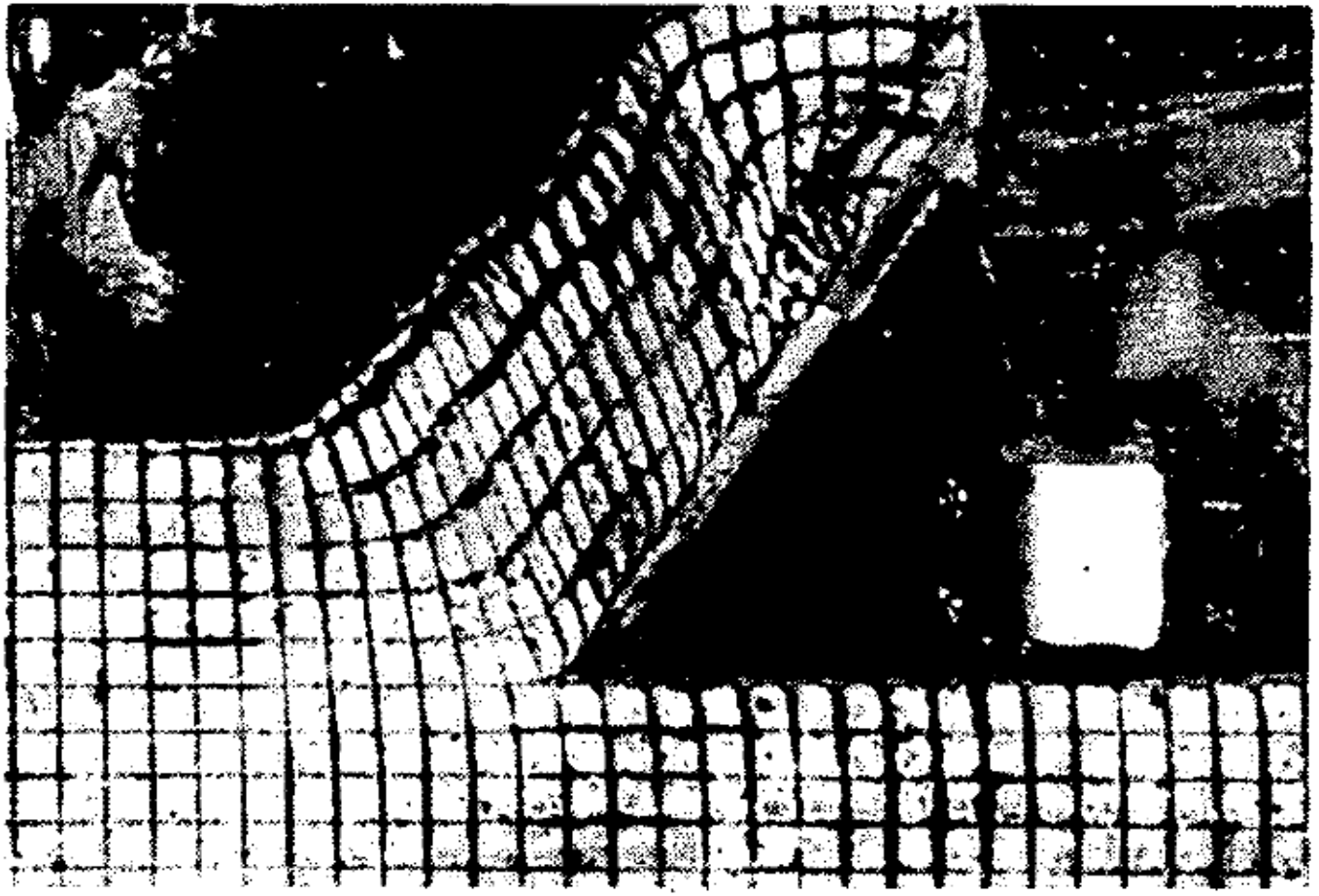
Hatamura Chijiiwa Plastic Loam



(d) Plastic loam

Hatamura Chijiiwa Plastic Clay



(e) Plastic clay

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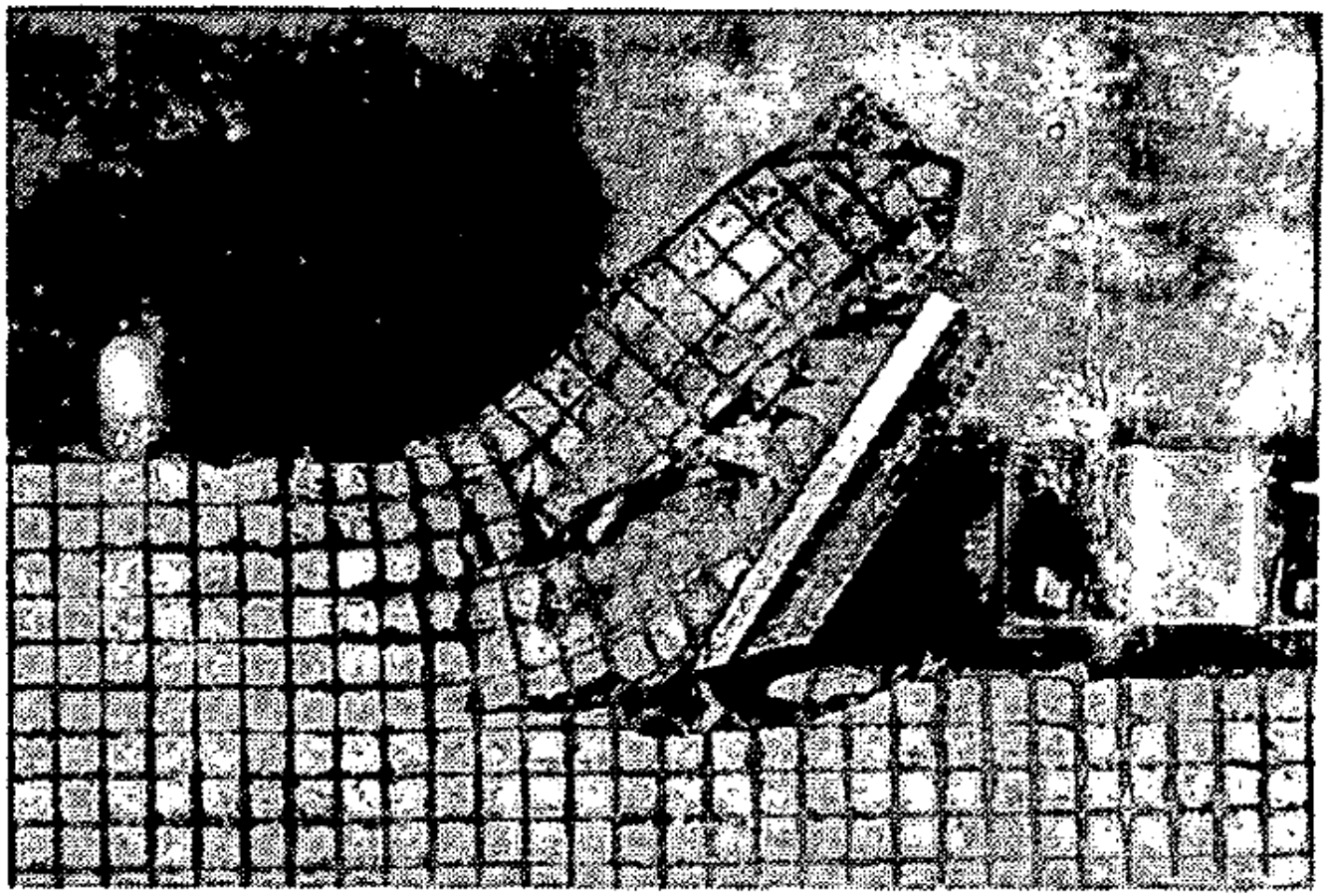
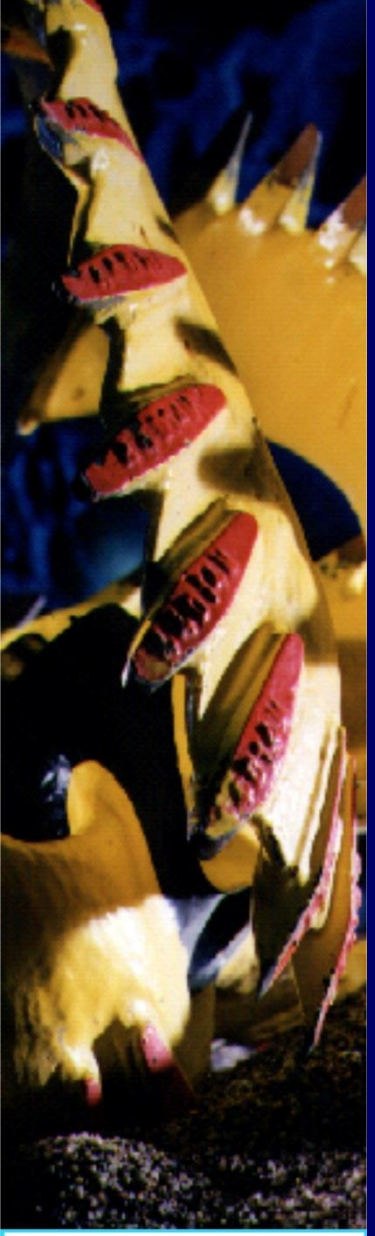
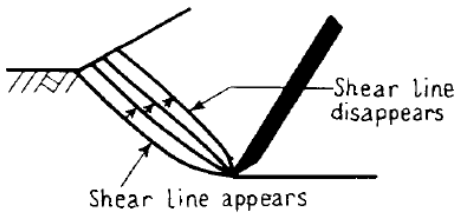
Hatamura Chijiiwa Compacted Loam



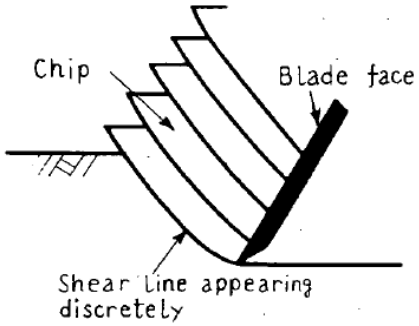
(f) Compacted loam

Hatamura Chijiiwa Failure Types





(a) Appearance of shear line



(b) Accumulation of chips

Fig. 4 Shear type

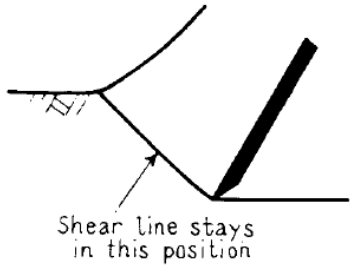


Fig. 5 Flow type

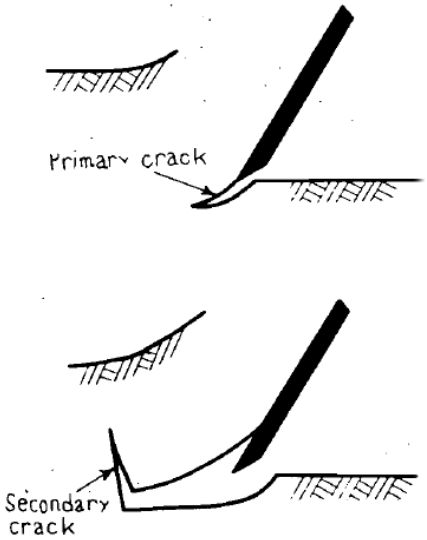
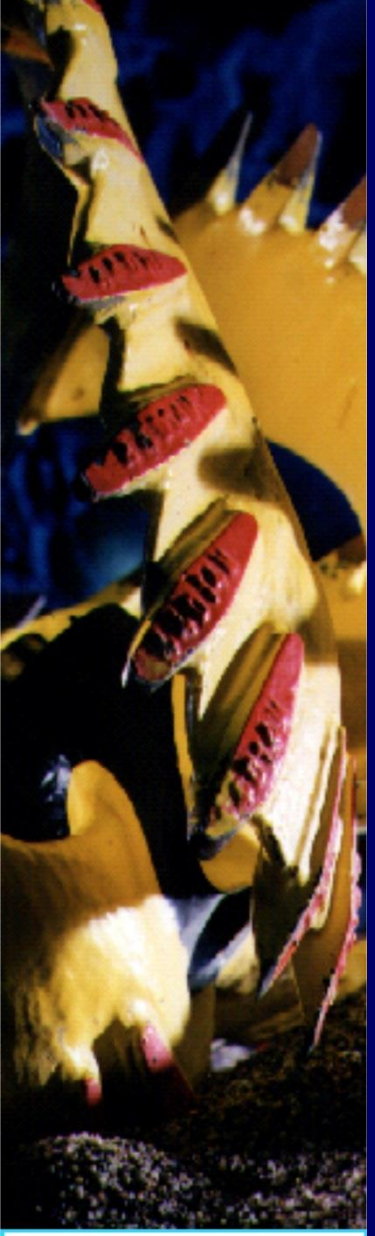


Fig. 6 Tear type



Cutting Mechanisms in Sand

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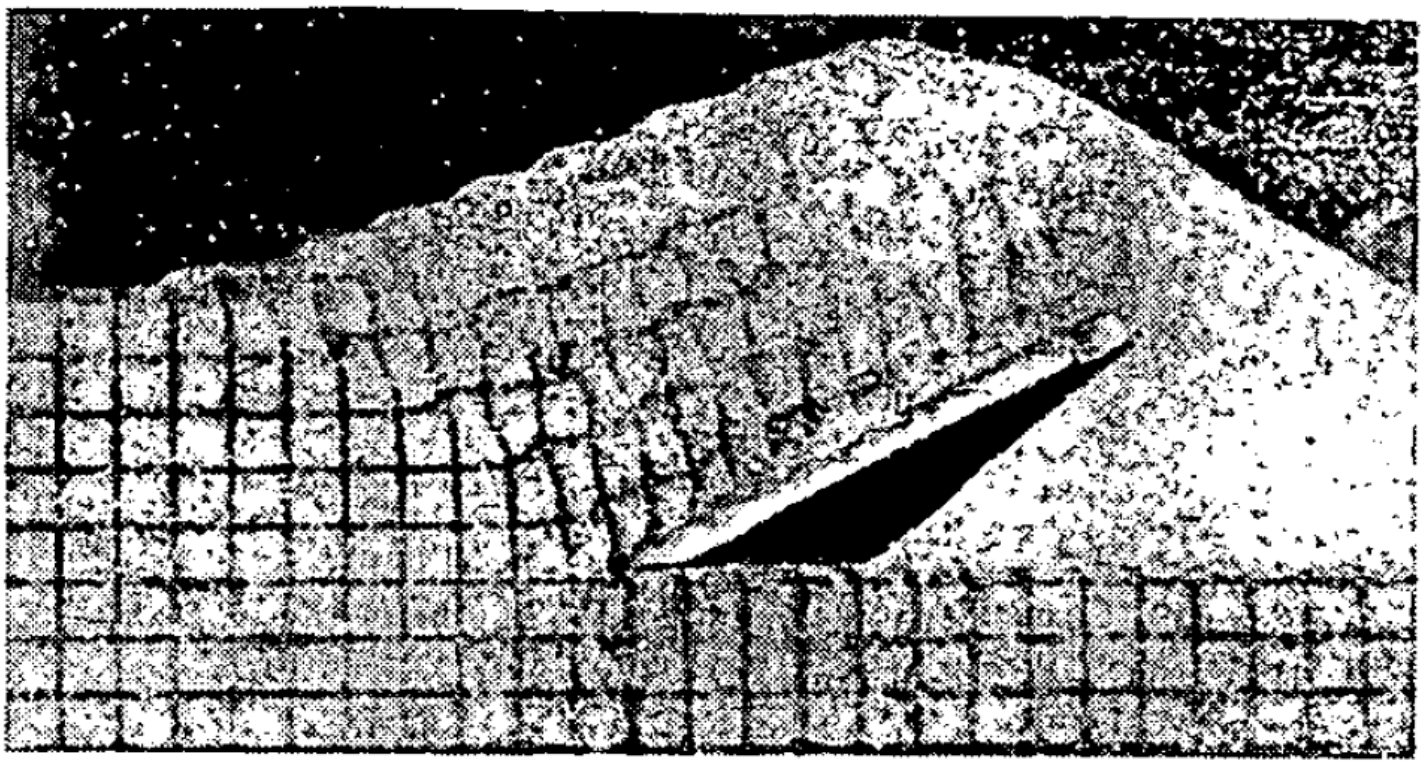
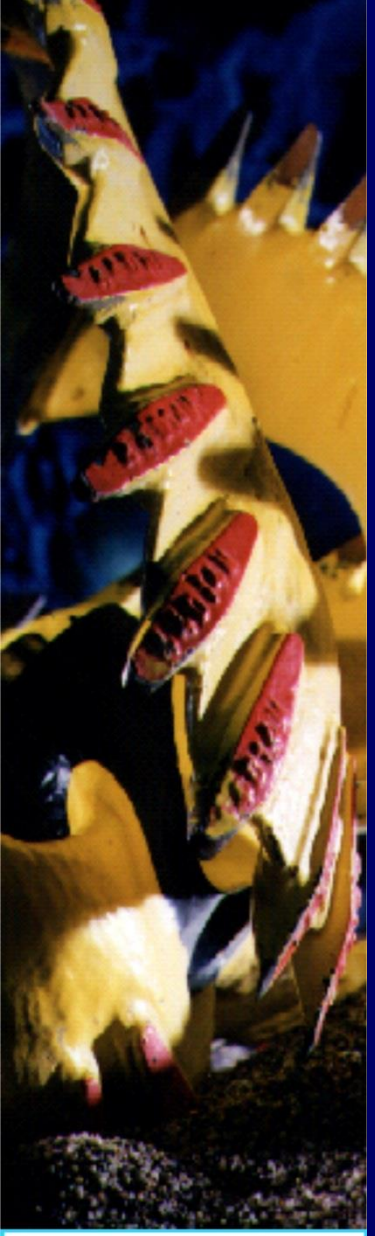
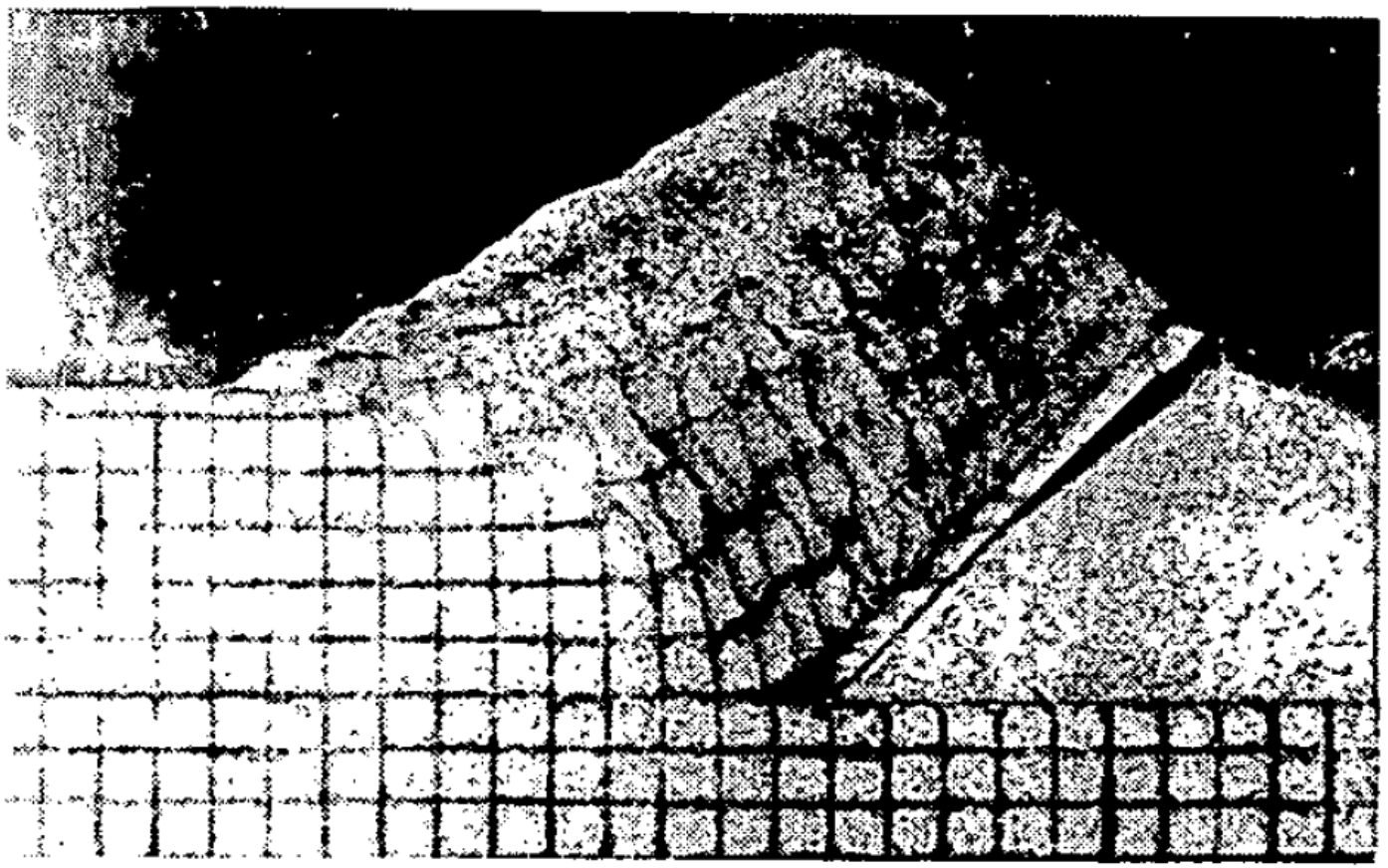
Hatamura Chijiiwa Dry Sand 30 deg.



(a) Cutting angle $\alpha = 30°$

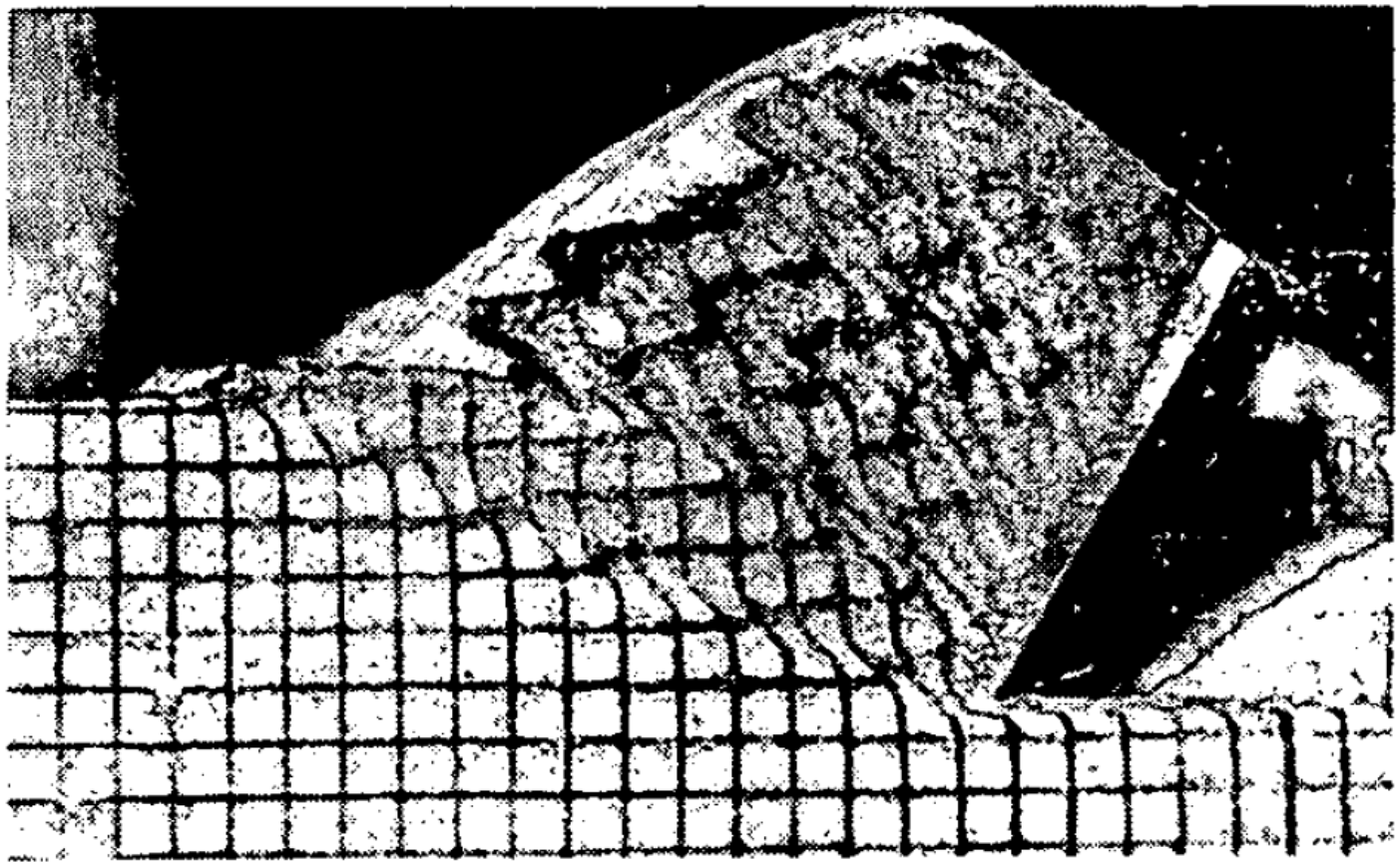
Hatamura Chijiiwa Dry Sand 45 deg.





(b) Cutting angle $\alpha = 45°$

Hatamura Chijiiwa Dry Sand 60 deg.



(c) Cutting angle $\alpha = 60°$

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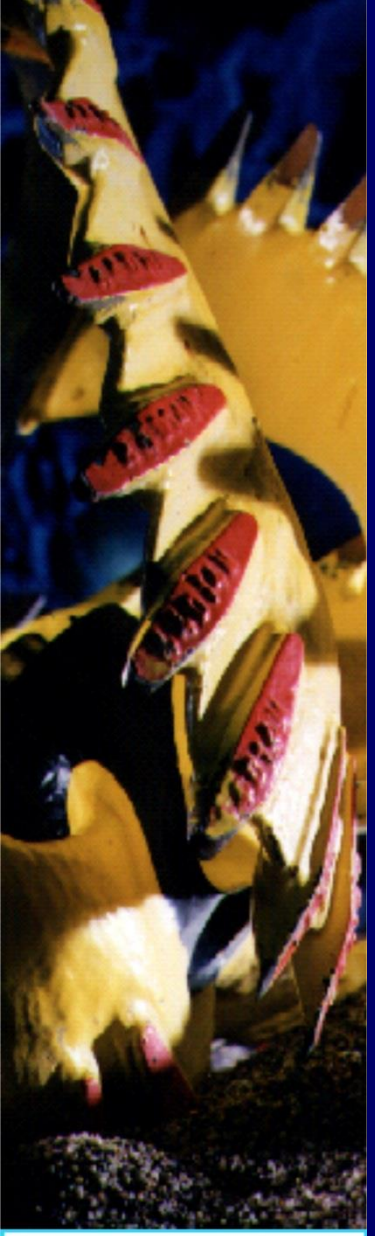
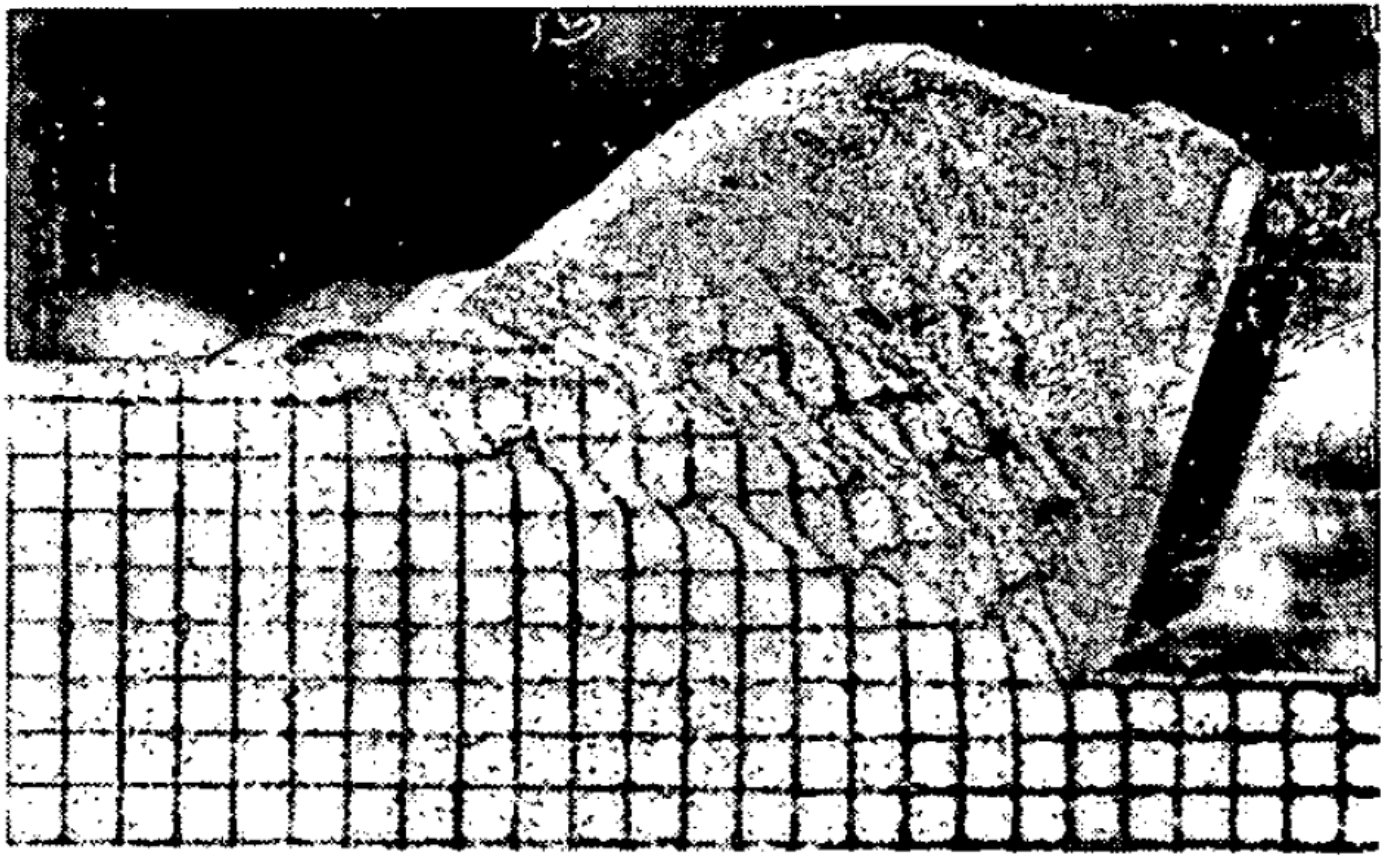
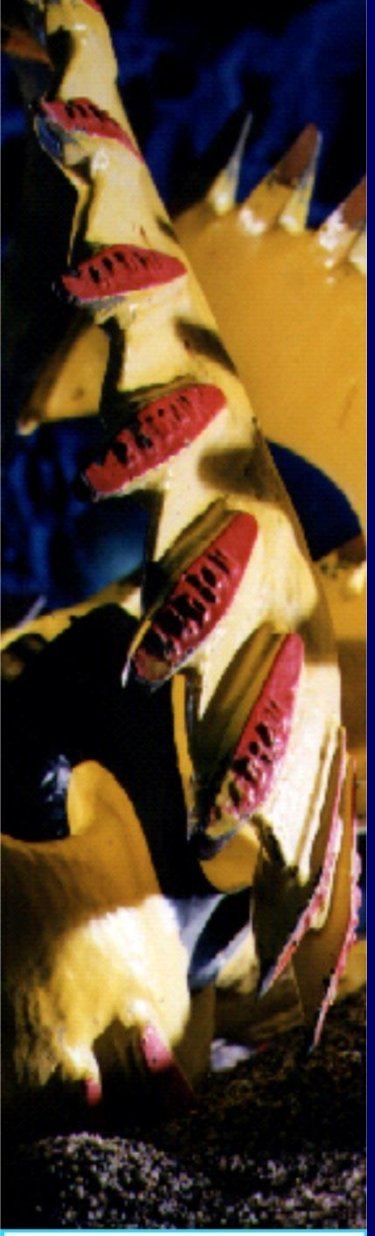
Hatamura Chijiiwa Dry Sand 75 deg.

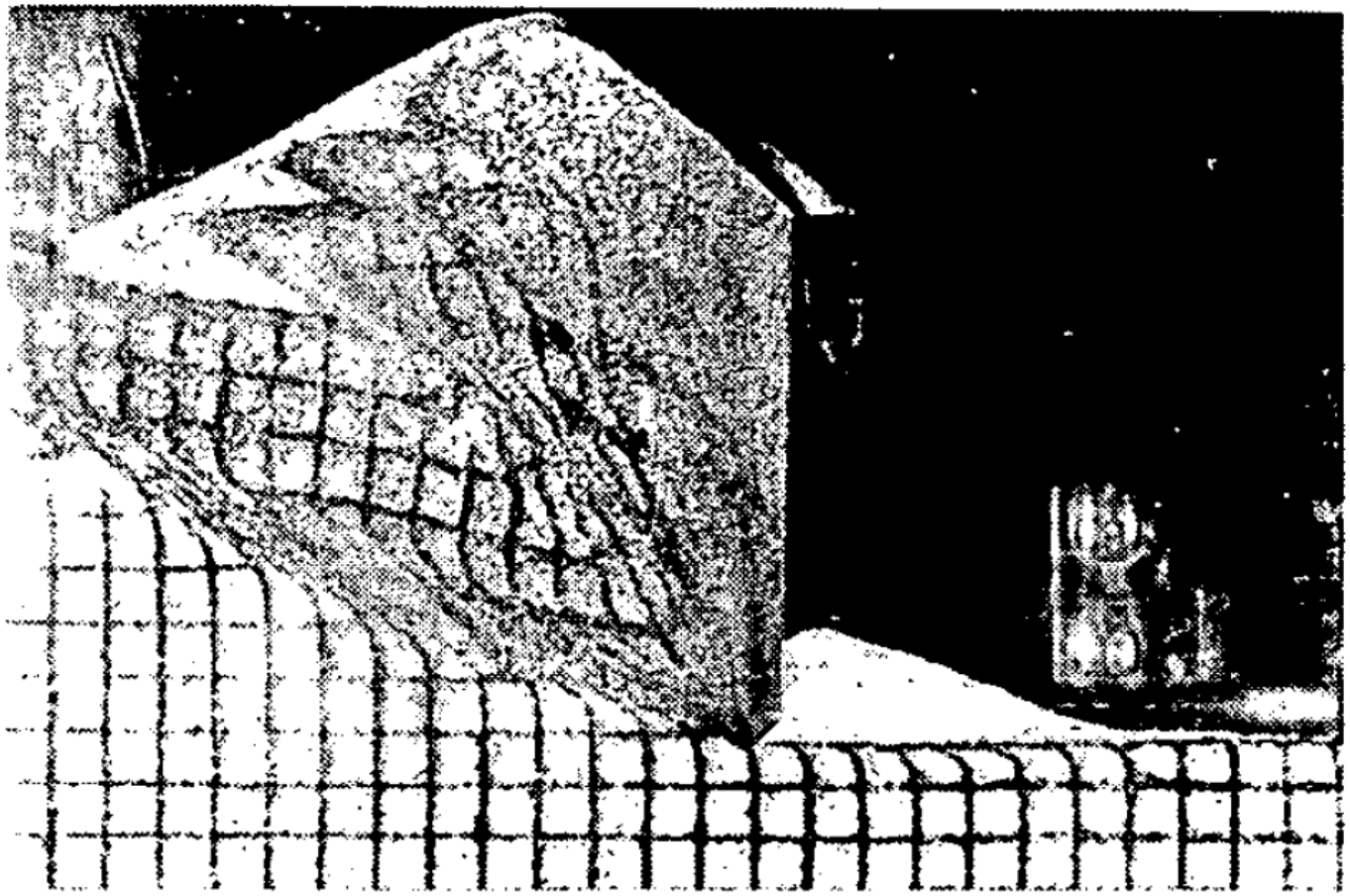




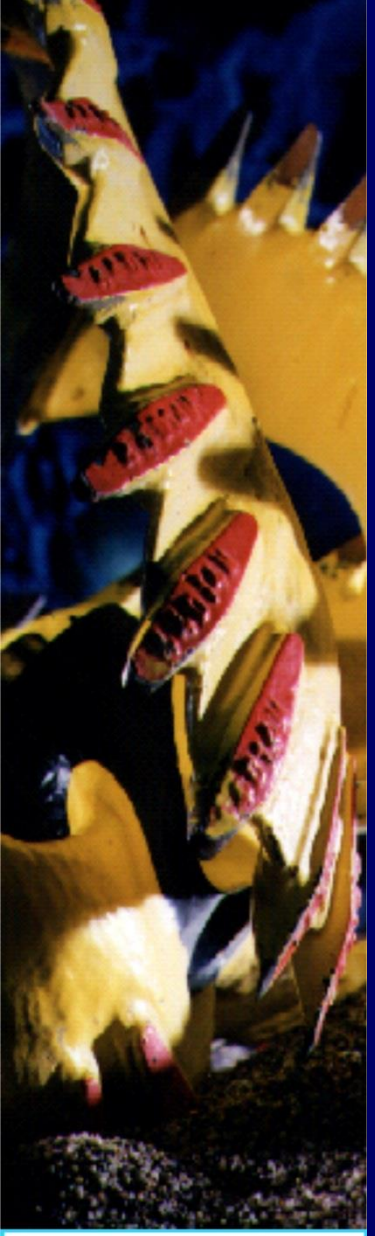
(d) Cutting angle $\alpha = 75^{\circ}$

Hatamura Chijiiwa Dry Sand 90 deg.





(e) Cutting angle $\alpha = 90°$



Cutting Mechanisms in Loam

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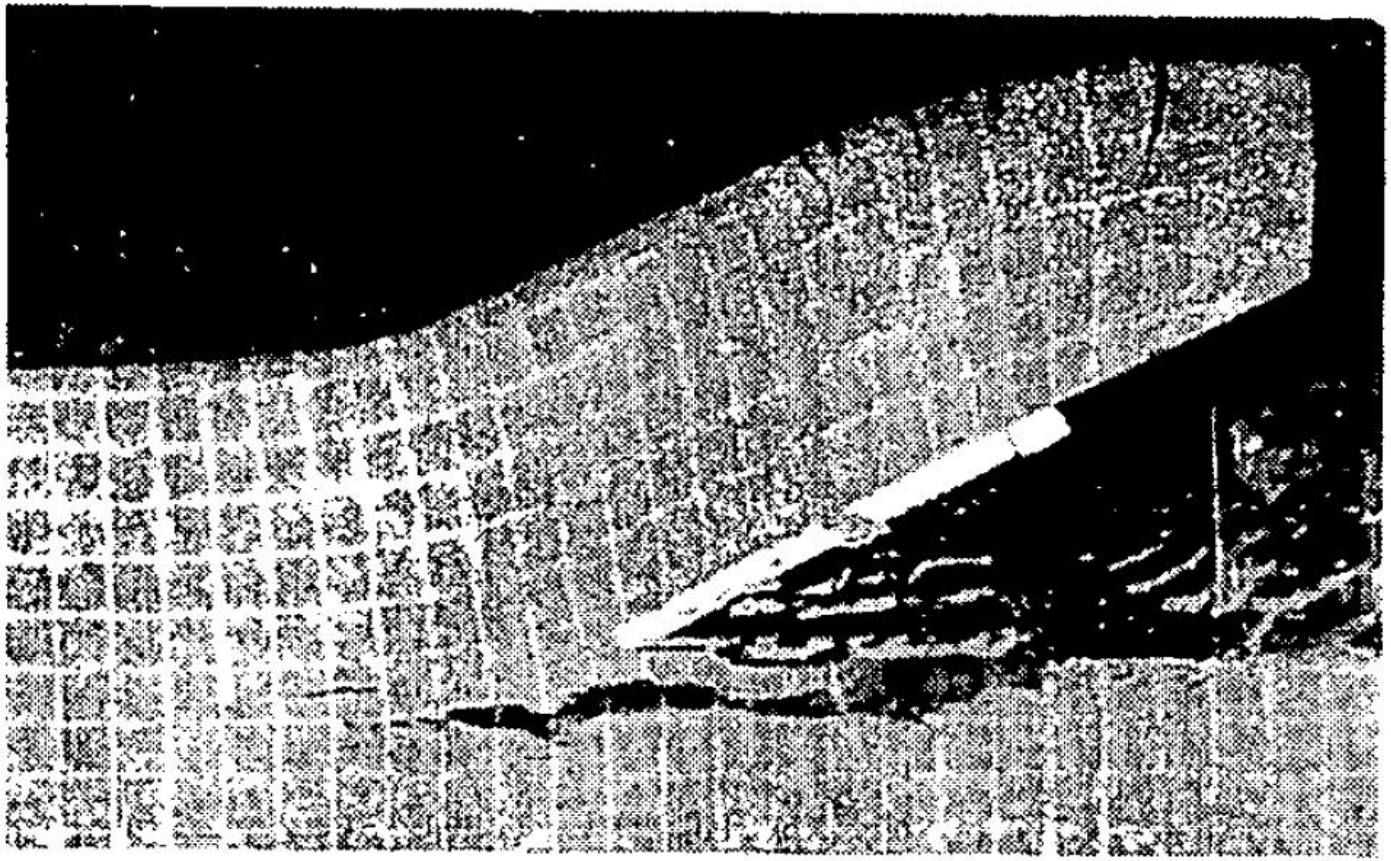
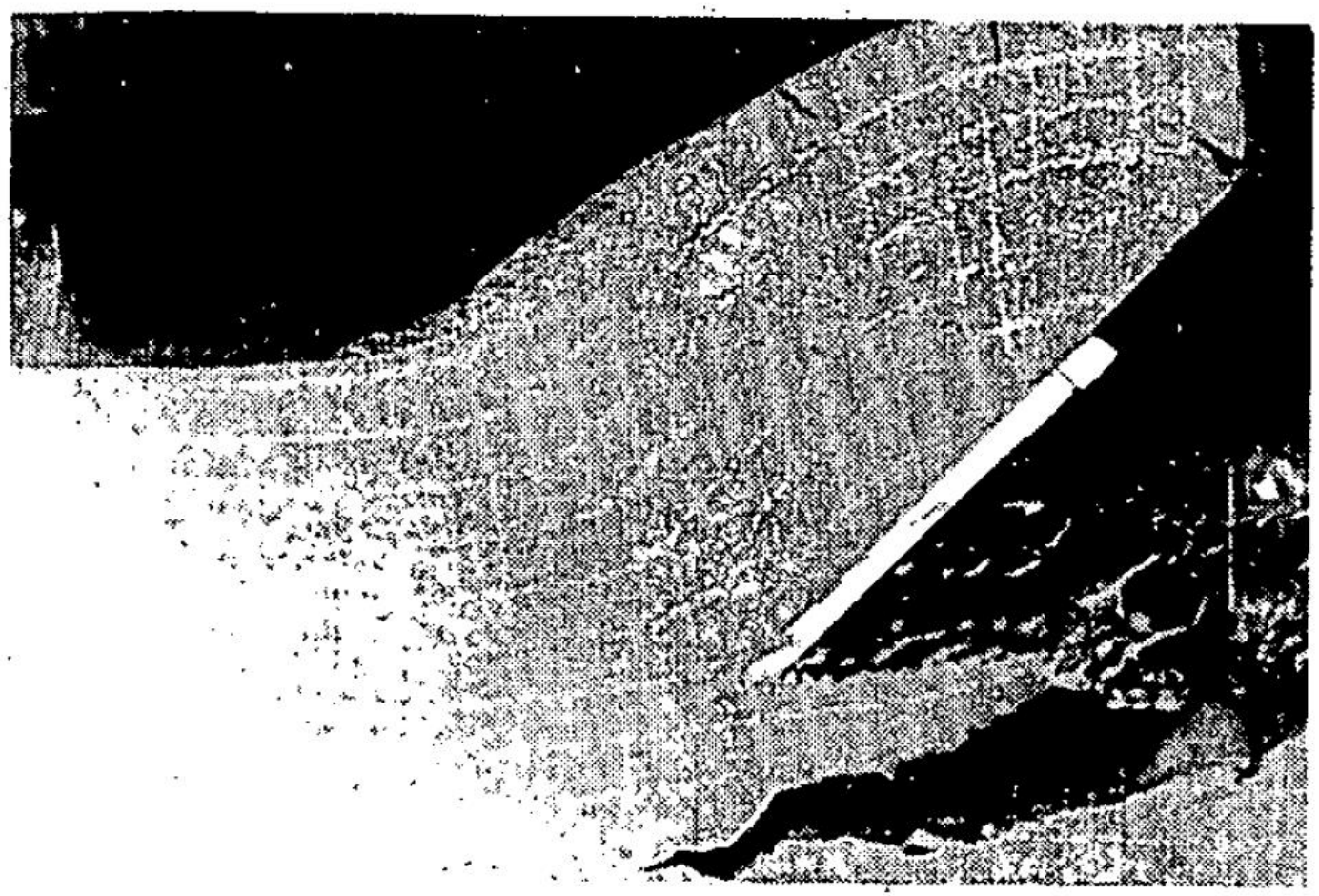
Hatamura Chijiiwa Plastic Loam 30 deg.



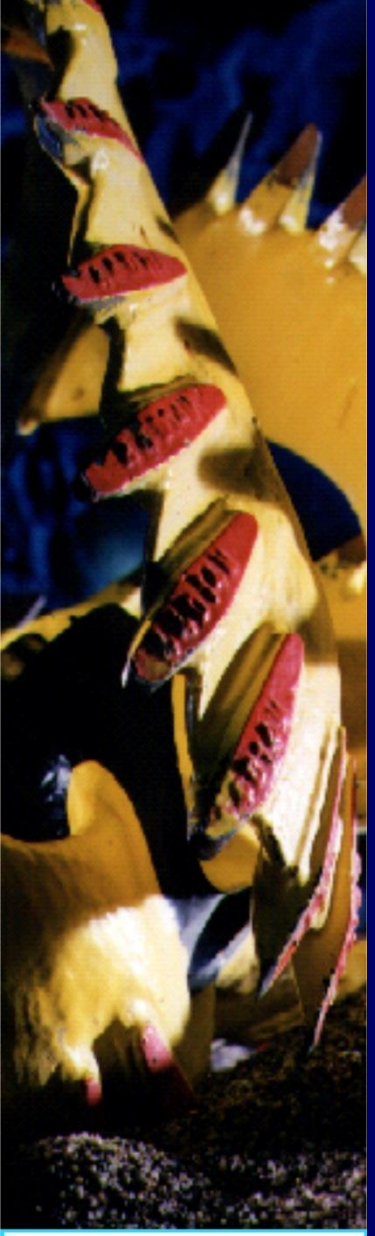
(a) Cutting angle $\alpha = 30°$

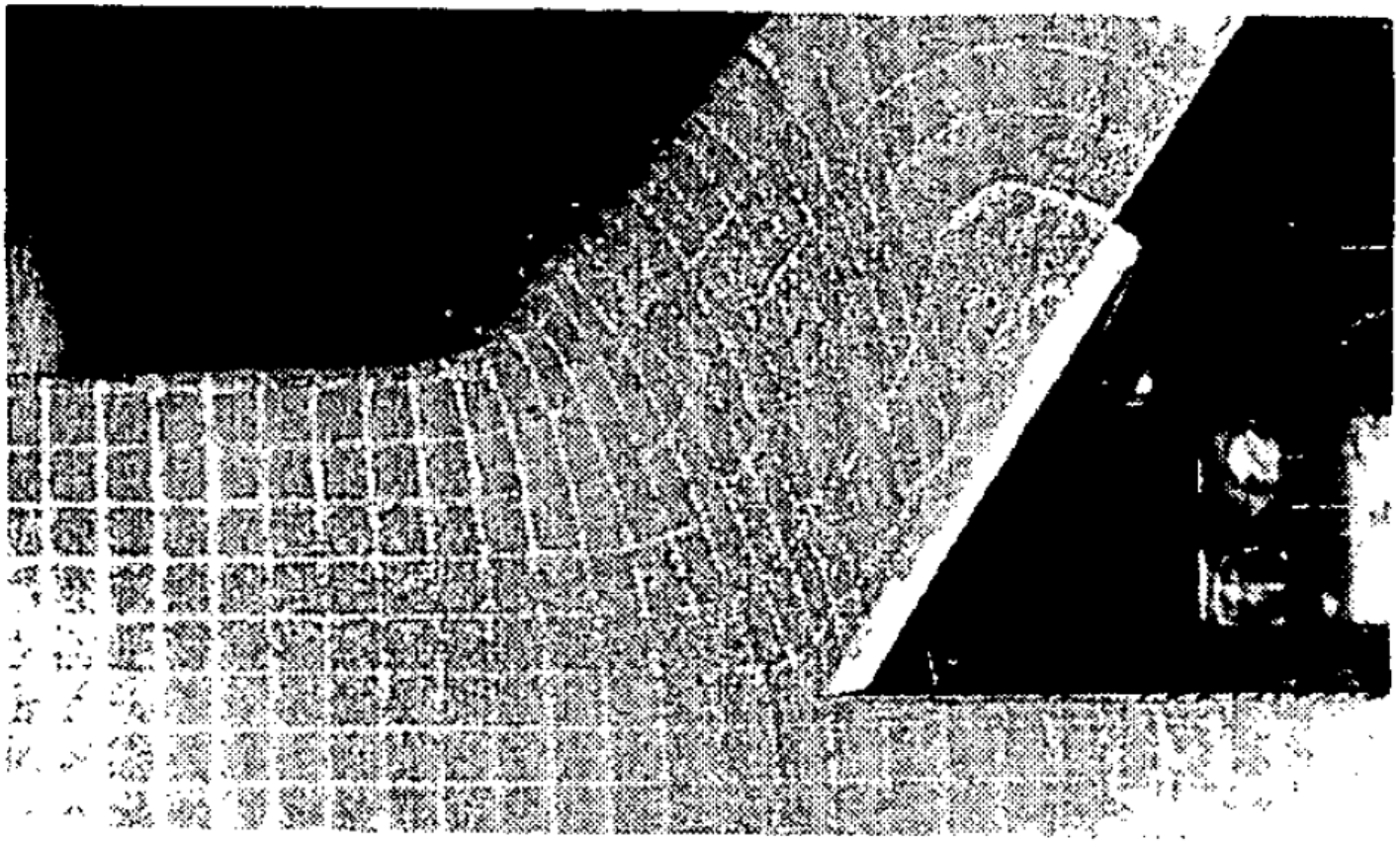
Hatamura Chijiiwa Plastic Loam 45 deg.



(b) Cutting angle $\alpha = 45°$

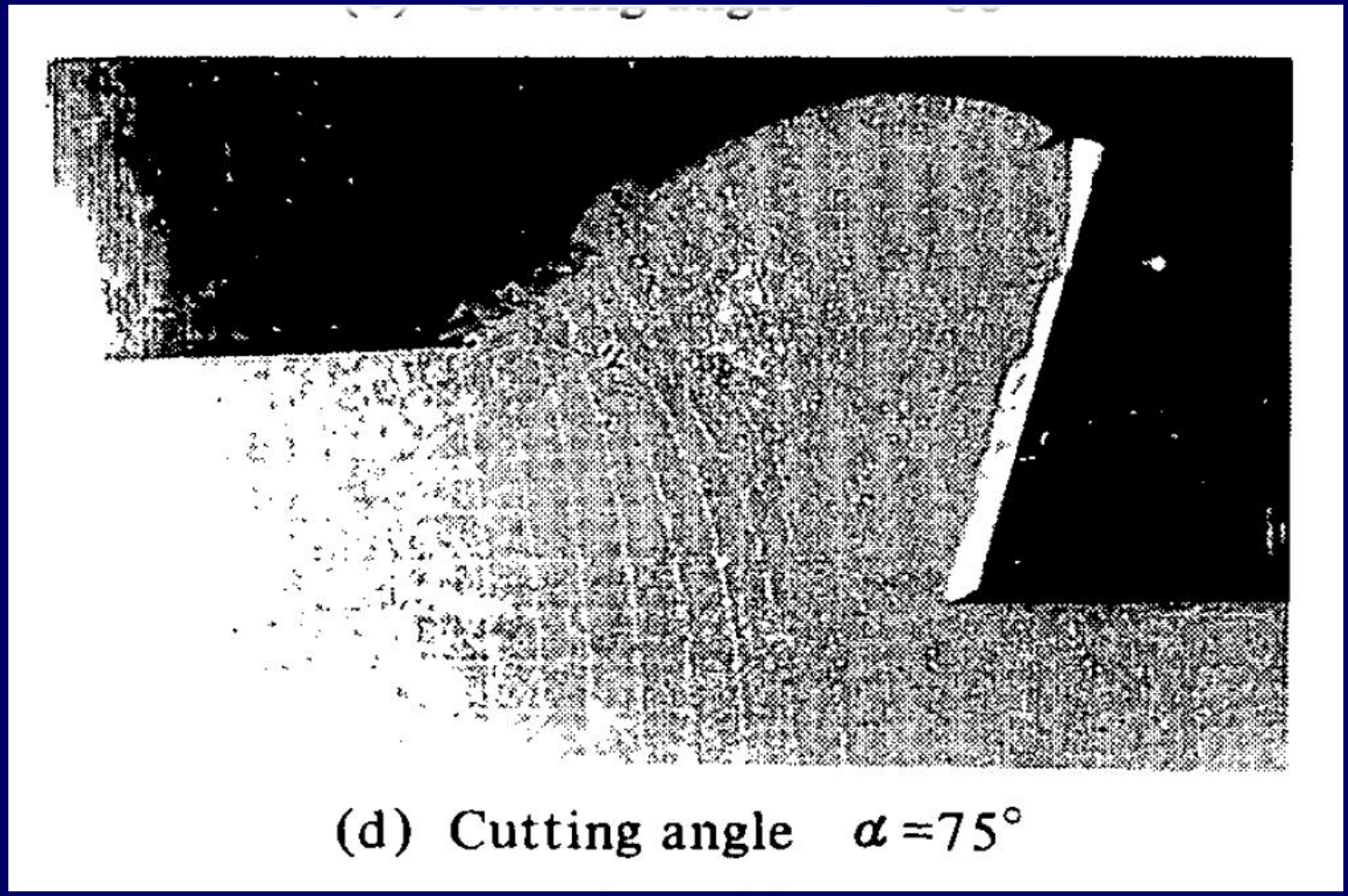
Hatamura Chijiiwa Plastic Loam 60 deg.





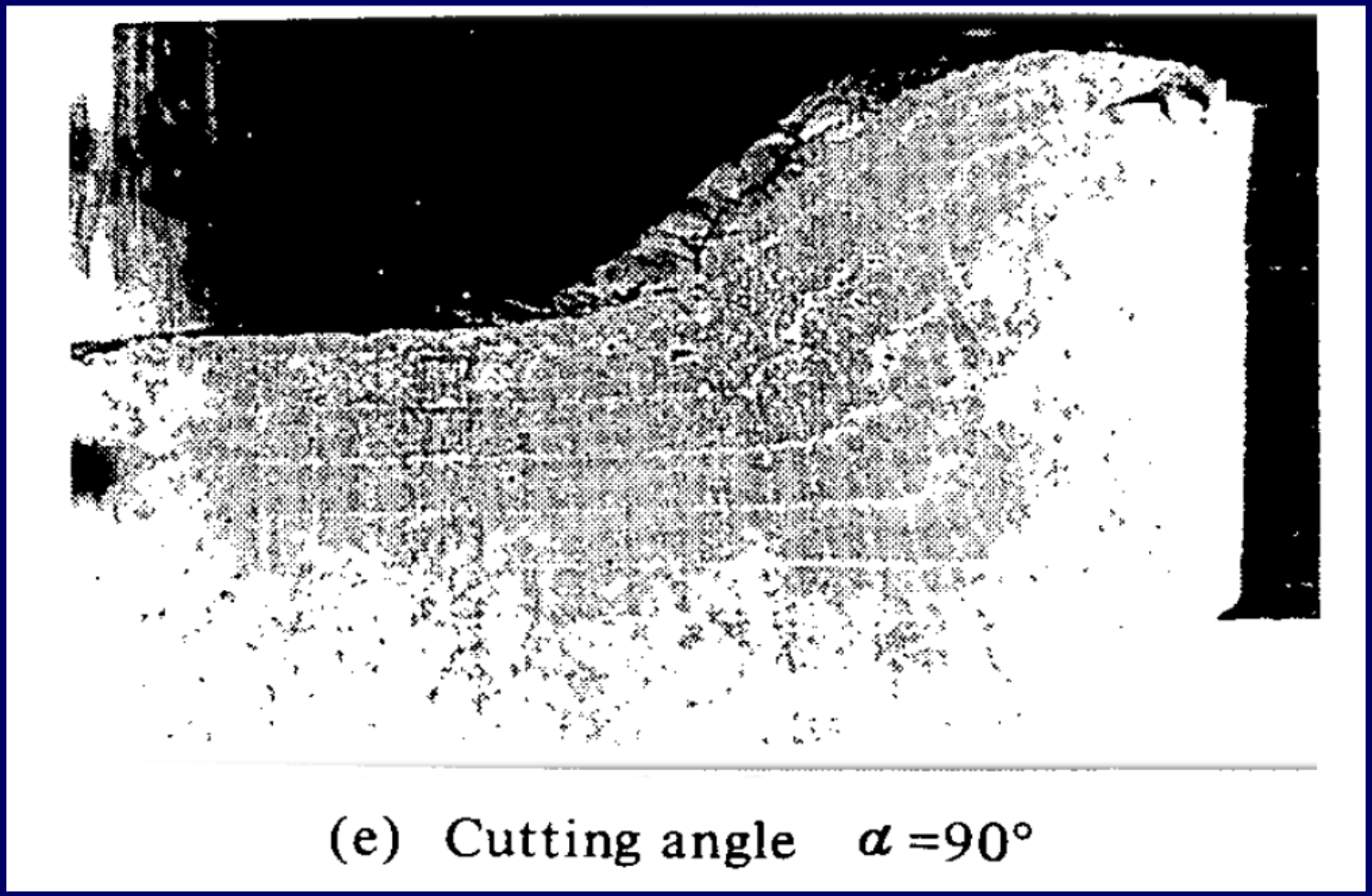
(c) Cutting angle $\alpha = 60°$

Hatamura Chijiiwa Plastic Loam 75 deg.

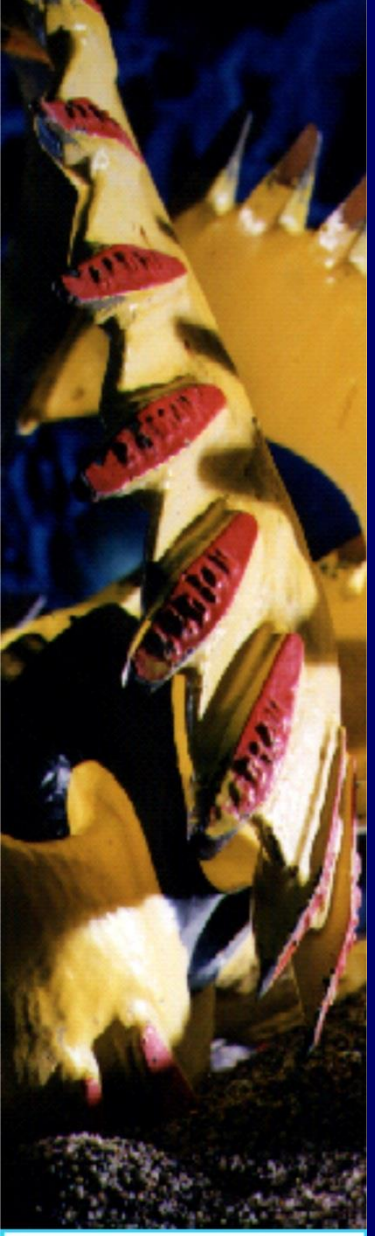


(d) Cutting angle $\alpha = 75°$

Hatamura Chijiiwa Plastic Loam 90 deg.



(e) Cutting angle $\alpha = 90°$



Cutting Mechanisms in Rock

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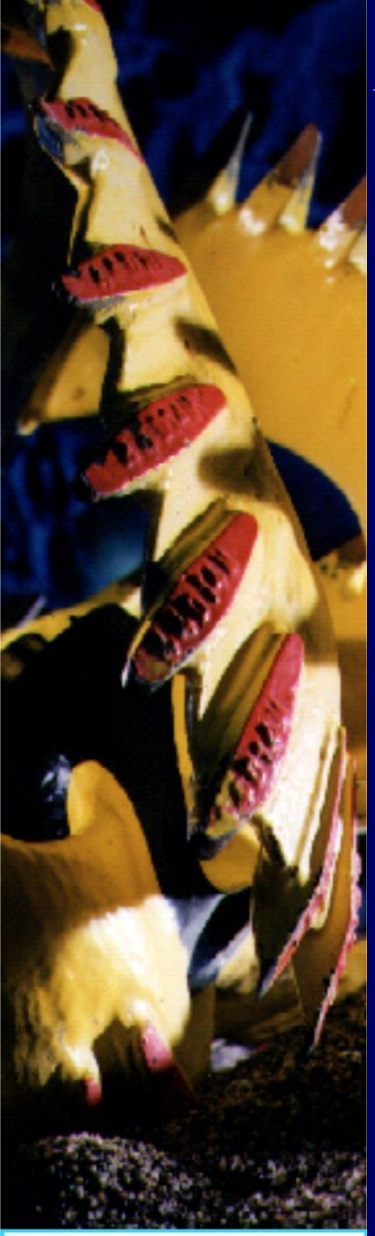
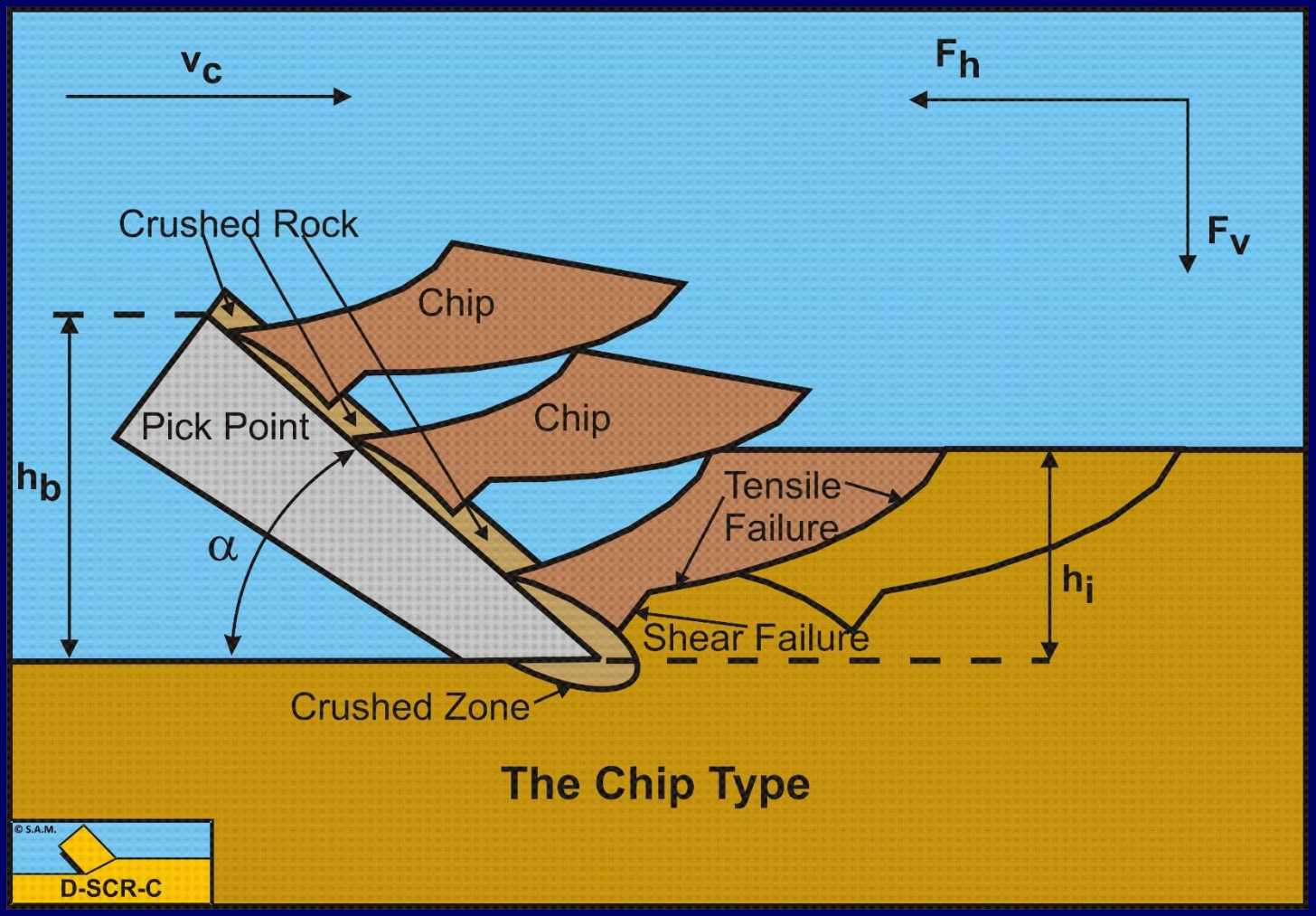
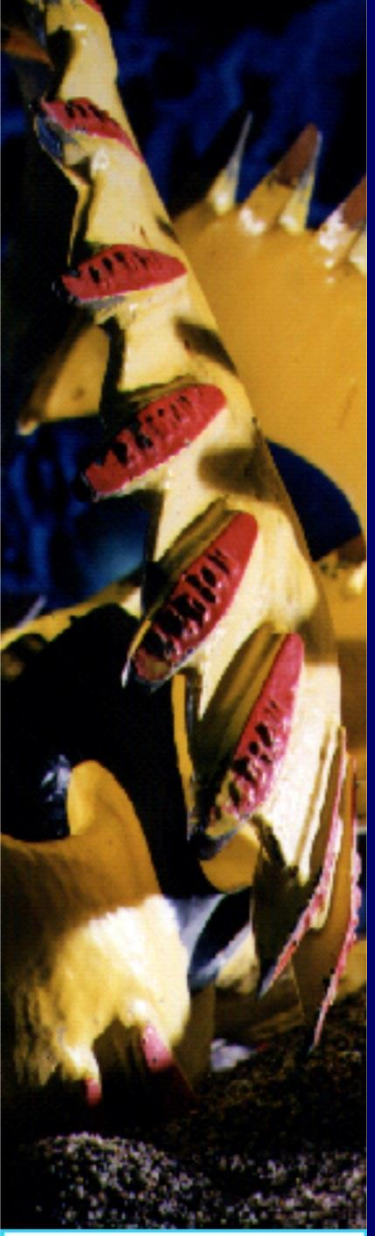
Cutting Mechanisms in Rock







Cutting Mechanisms

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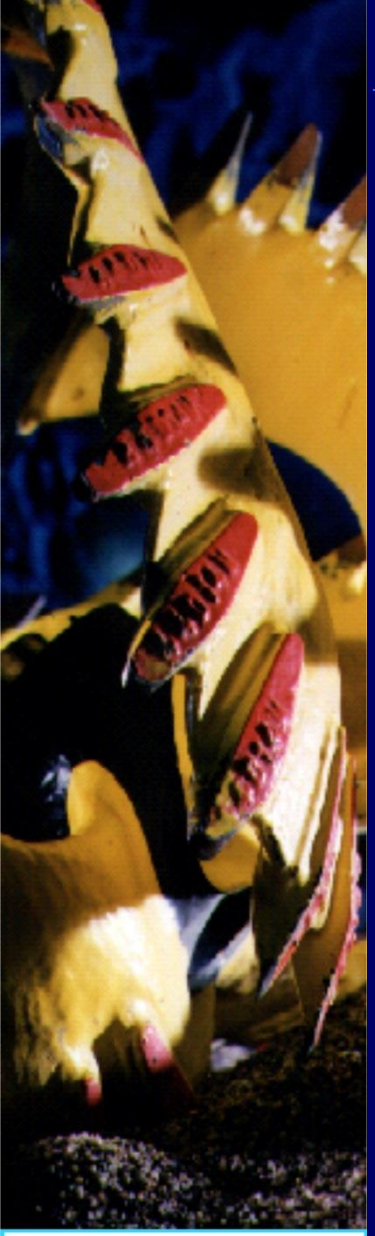
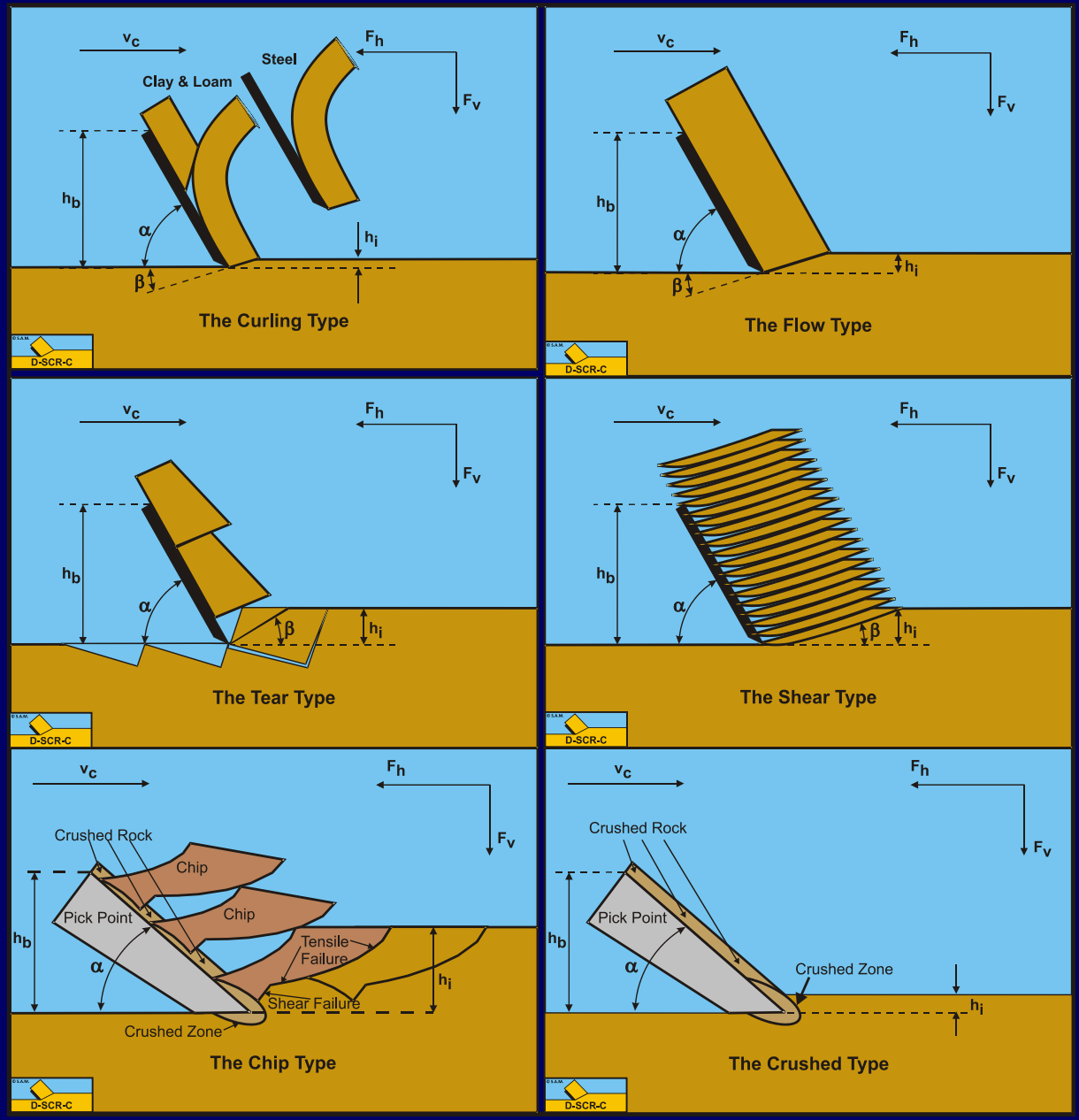
Cutting Mechanisms





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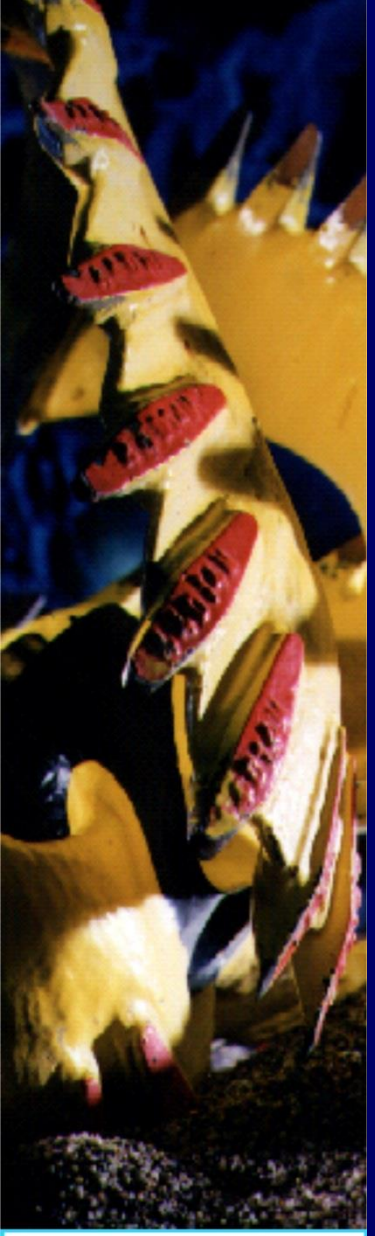

Cutting Forces

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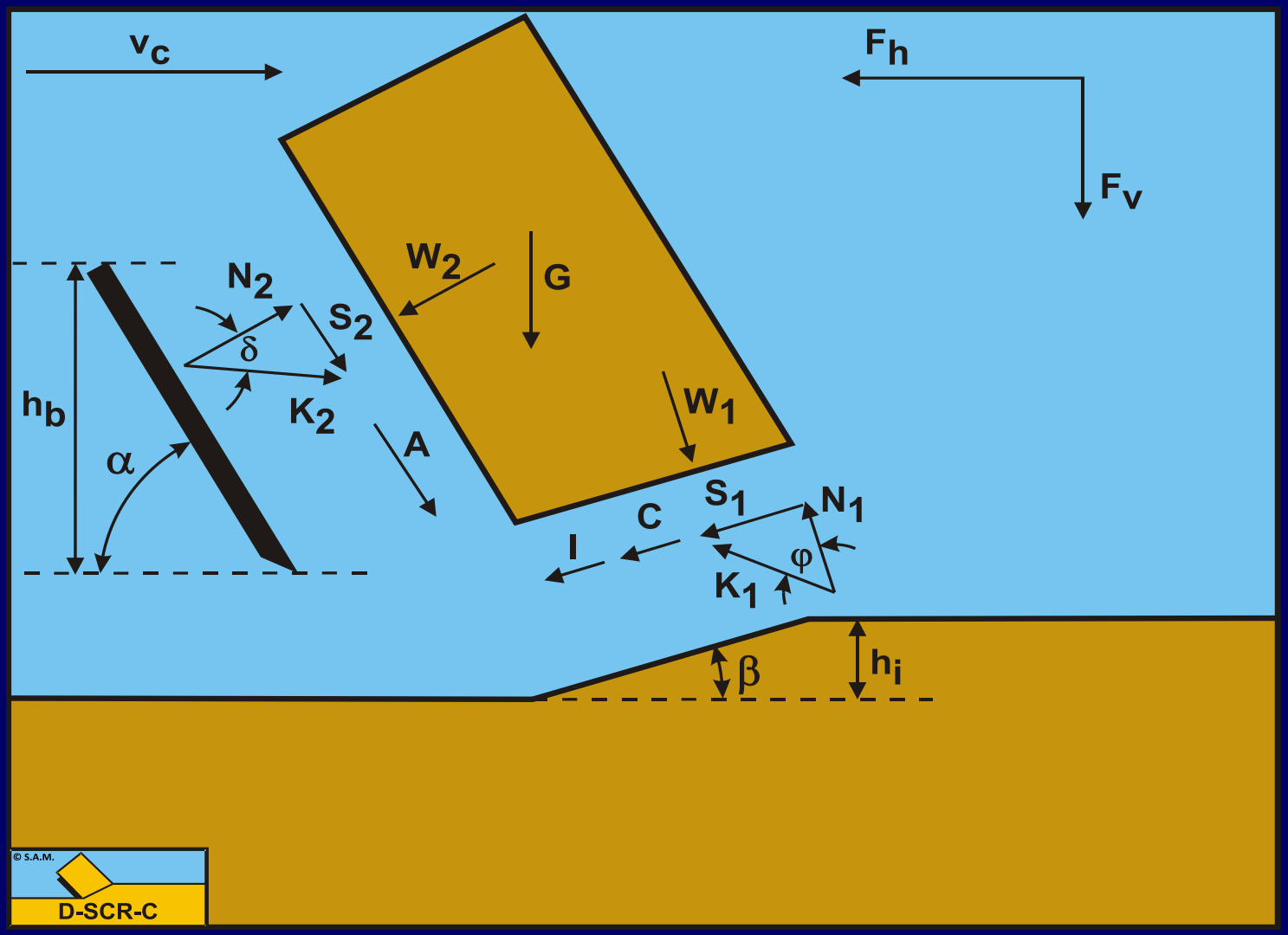
Forces on the Layer Cut



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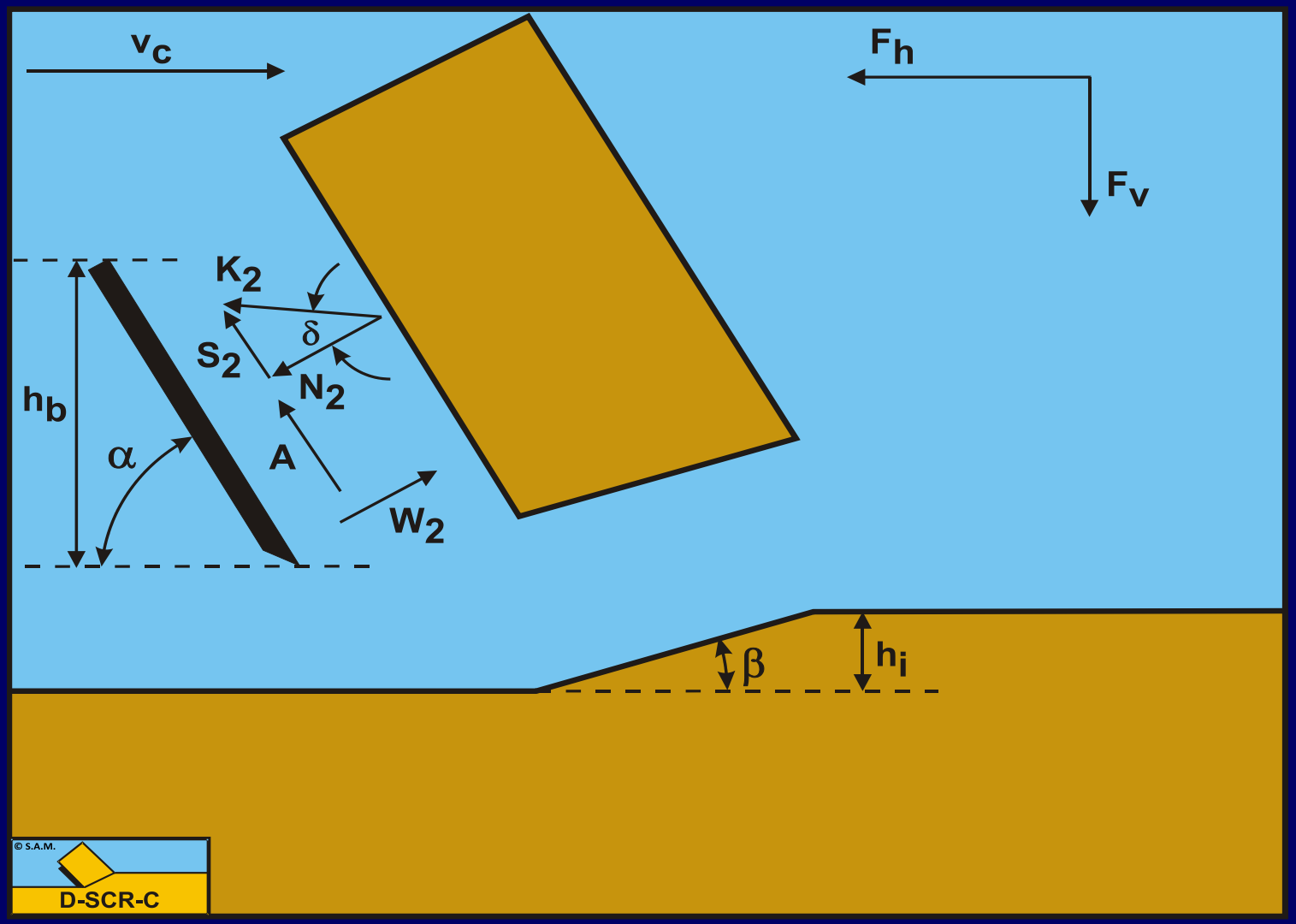
Forces on the Blade



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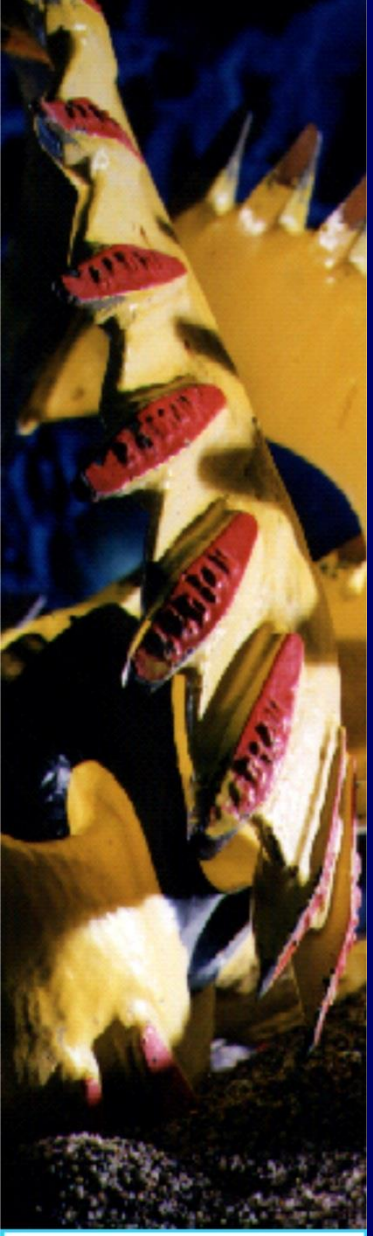


Resulting Equations

$$K_2 = \frac{W_2 \cdot \sin(\alpha+\beta+\varphi) + W_1 \cdot \sin(\varphi) + G \cdot \sin(\beta+\varphi)}{\sin(\alpha+\beta+\delta+\varphi)}$$

$$\frac{+I \cdot \cos(\varphi) + C \cdot \cos(\varphi) - A \cdot \cos(\alpha+\beta+\varphi)}{\sin(\alpha+\beta+\delta+\varphi)}$$

$$F_h = -W_2 \cdot \sin(\alpha) + K_2 \cdot \sin(\alpha+\delta) + A \cdot \cos(\alpha)$$

$$F_v = -W_2 \cdot \cos(\alpha) + K_2 \cdot \cos(\alpha+\delta) - A \cdot \sin(\alpha)$$

Which Terms in Which Soil

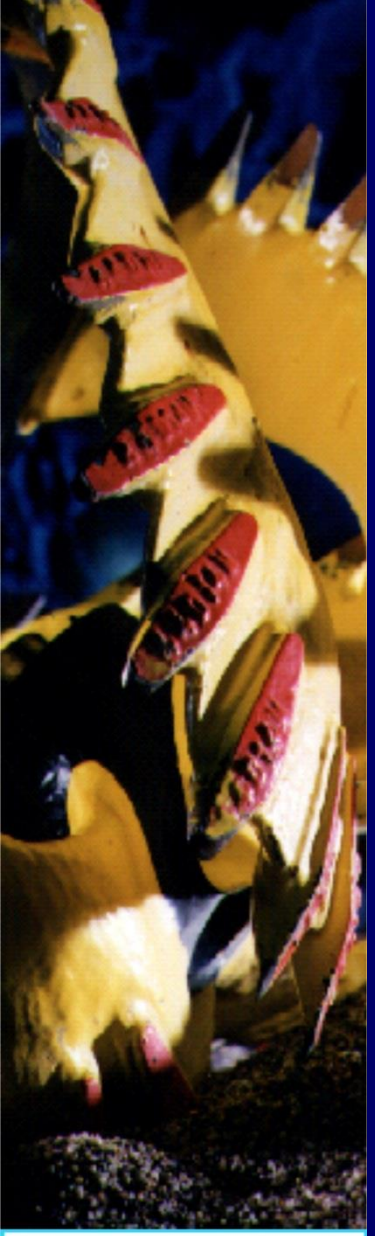
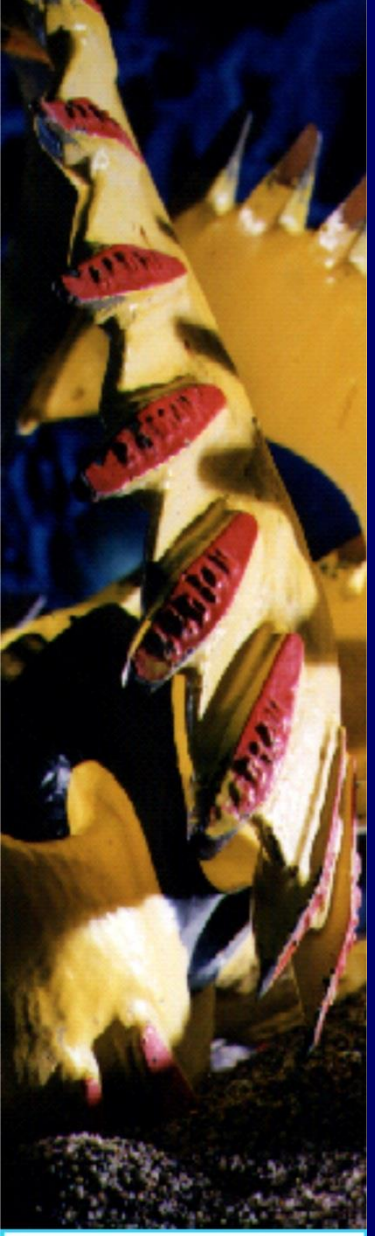


Table 1. The influences for each type of soil.

	Gravity	Inertia	Pore Pressure	Cohesion	Adhesion	Friction
Dry sand	■	■				■
Saturated sand			■			■
Clay				■	■	
Atmospheric rock				■		■
Hyperbaric rock			■	■		■



Cutting Forces with Wedge

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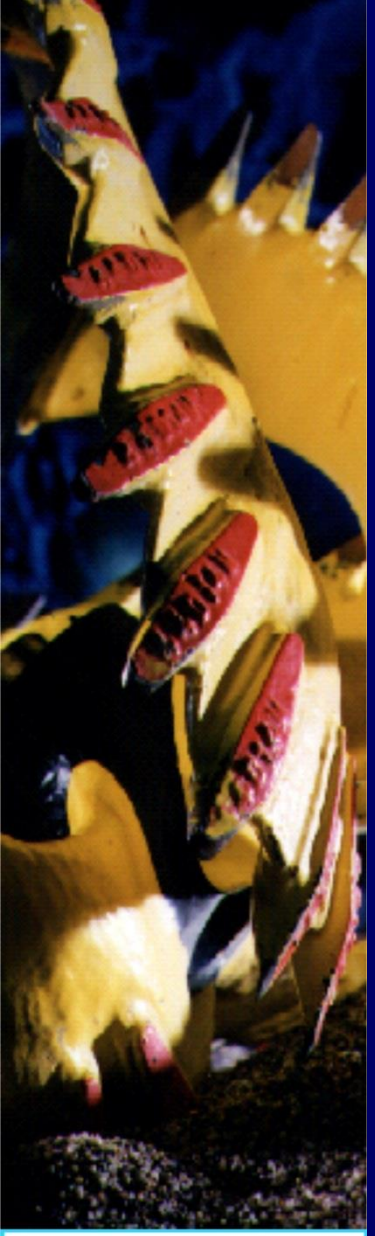
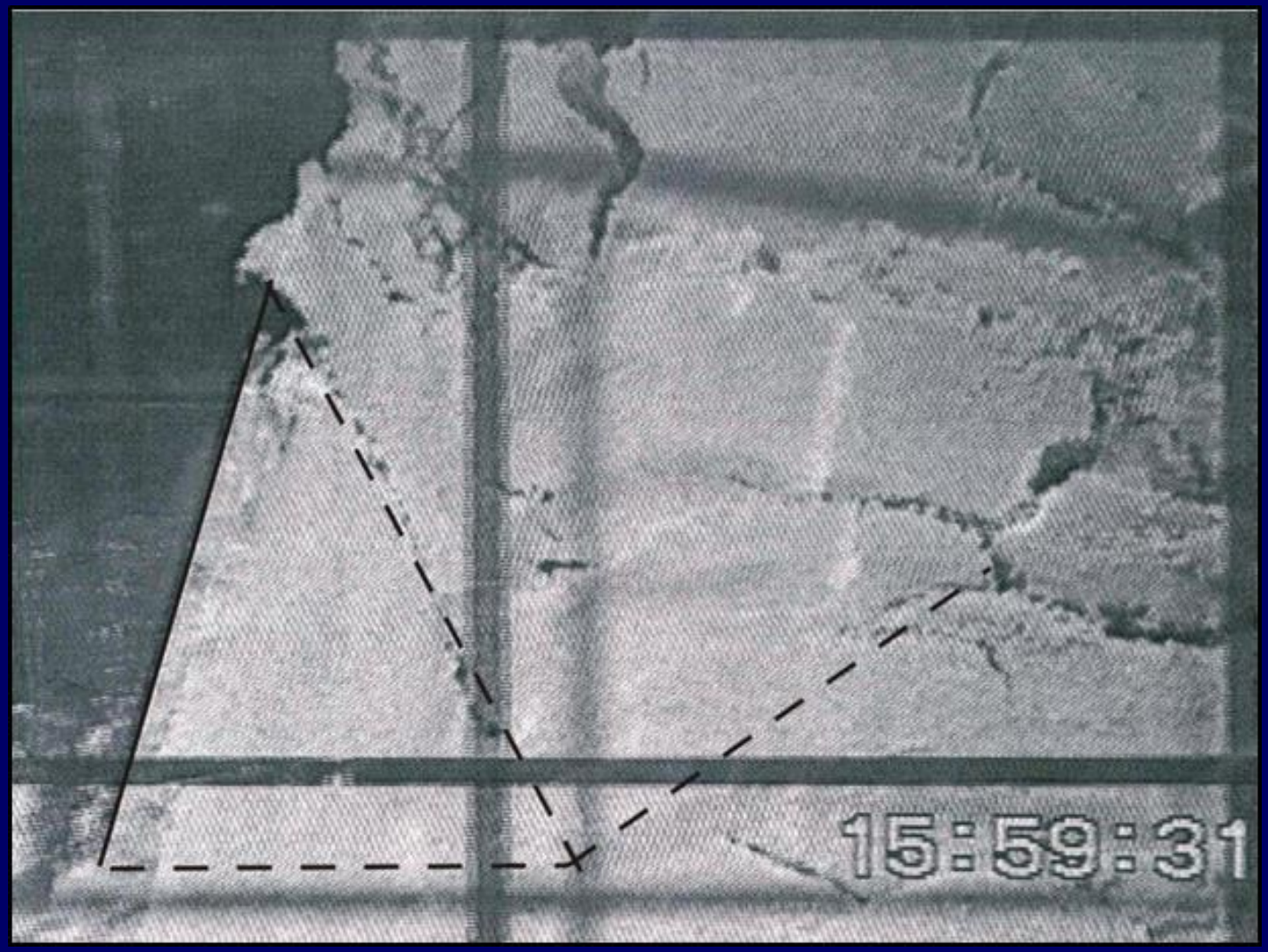


A Wedge in Dry Sand



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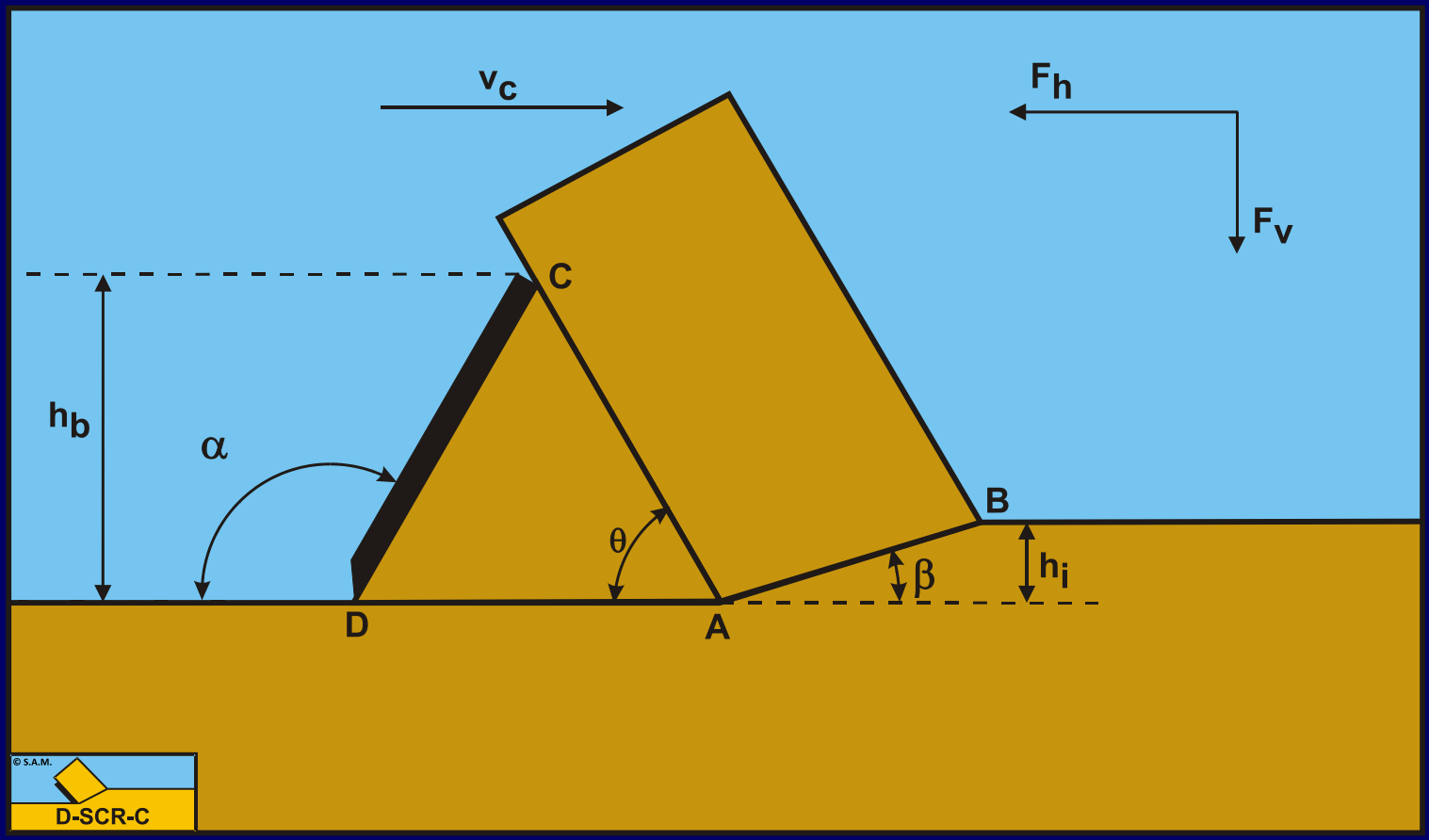
Wedge Definitions



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CONCLUSIONS

- 6 cutting mechanisms are identified for ‘small’ blade angles.
- Dry Sand: The Shear Type.
- Saturated Sand: The Shear Type.
- Clay & Loam: The Flow Type, The Curling Type & The Tear Type.
- Atmospheric Rock: The Tear Type (Brittle Tensile), The Shear Type (Brittle Shear) & The Chip Type (Combination of Brittle Shear & Tensile).
- Hyperbaric Rock: The Crushed Type (Cataclastic Failure).

Questions?

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