Chemistry and Physics of Casting Materials

Dr Stephen Hsu

Gypsum

Plaster of Paris (1800 – 1850)

$CaSO_4.{}^{1}/_{2}\,H_2O$

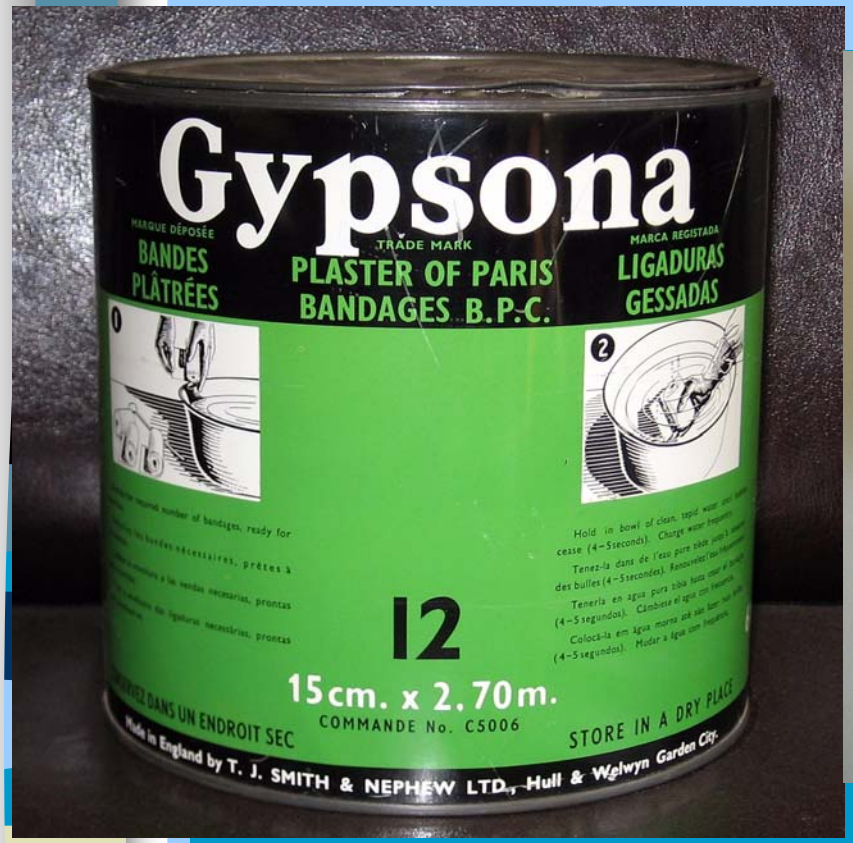
↓

$CaSO_4.2H_2O$

+

Heat

Plaster Bandages
Cotton : crinoline and leno cloth


Gypsona
MARQUE DÉPOSÉE
BANDES PLÂTRÉES
TRADE MARK
PLASTER OF PARIS BANDAGES B.P.C.
MARCA REGISTADA
LIGADURAS GESSADAS
12
15cm. x 2.70m.
COMMANDE No. C5006
STORE IN A DRY PLACE
Made in England by T. J. SMITH & NEPHEW LTD., Hull & Welwyn Garden City.


GREATCARE
GREATCARE MED
PLASTER OF PARIS BANDAG
3" x 2.7M

Synthetic Resin – 1970's

Polyurethane

Cellulose acetate

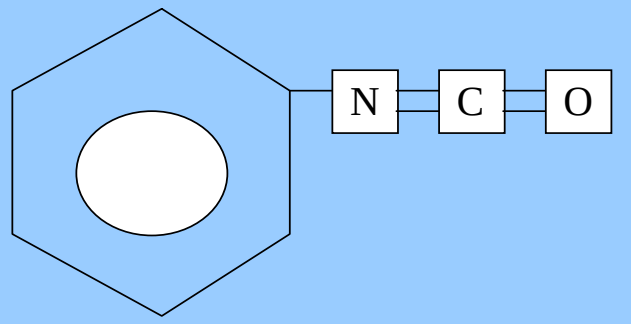
Aluminosilicate glass

Thermoplastic linear polymer

Activation of Resin

Material	Activator
Polyurethane	Water
Cellulose acetate	Acetone solvent
Aluminosilicate glass	Water
Thermoplastic polymer	Hot Water

Polyurethane Resin



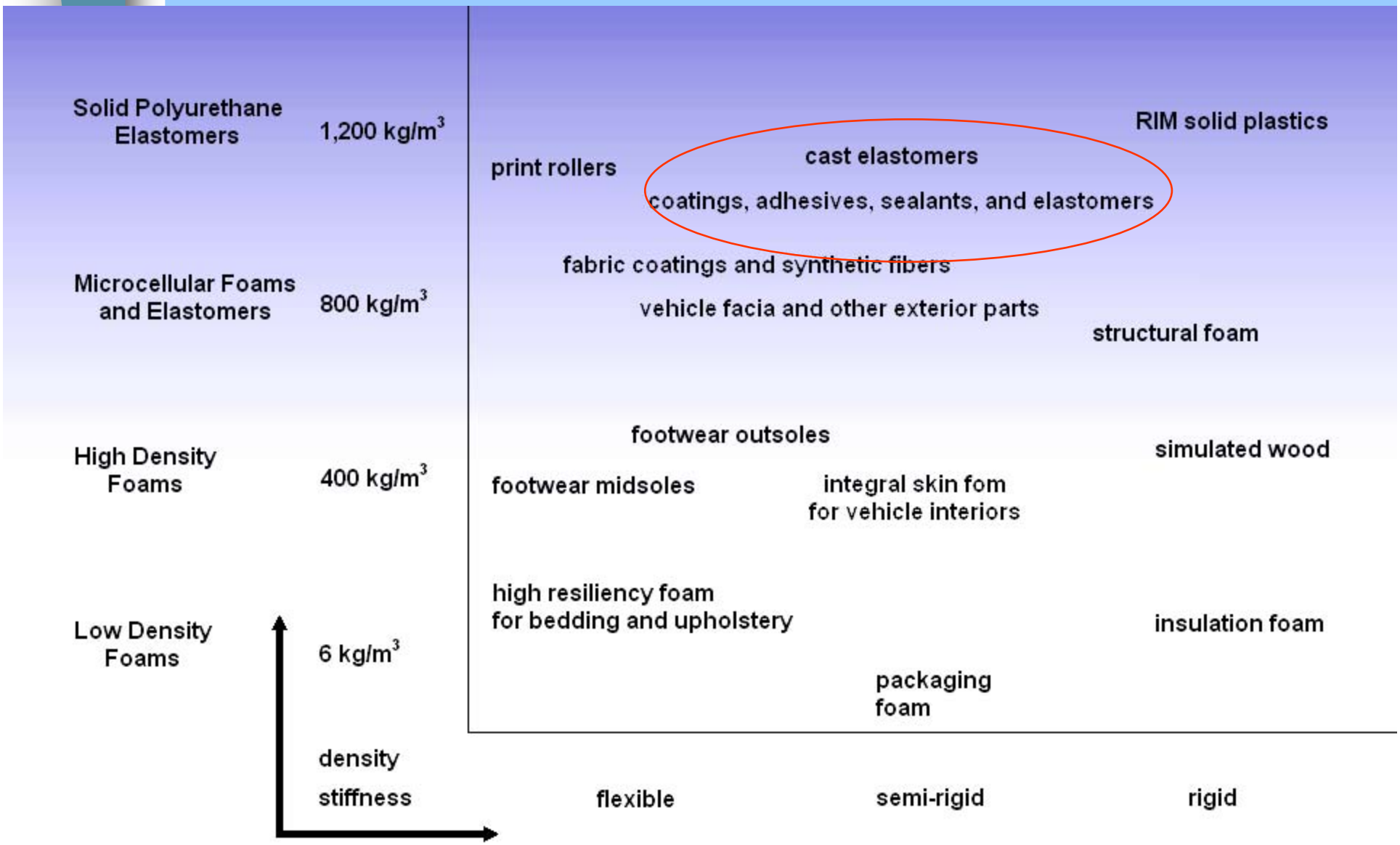
The prepolymer urethane resin

Stablilizer

Anti-foaming agent

Surfactant

$C_6H_5.NCO$


Solid Polyurethane Elastomers
1,200 kg/m3
Microcellular Foams and Elastomers
800 kg/m3
High Density Foams
400 kg/m3
Low Density Foams
6 kg/m3
density
stiffness
flexible
semi-rigid
rigid
print rollers
cast elastomers
coatings, adhesives, sealants, and elastomers
RIM solid plastics
fabric coatings and synthetic fibers
vehicle facia and other exterior parts
structural foam
footwear outsoles
simulated wood
footwear midsoles
integral skin fom for vehicle interiors
high resiliency foam for bedding and upholstery
insulation foam
packaging foam

Resin Bandages

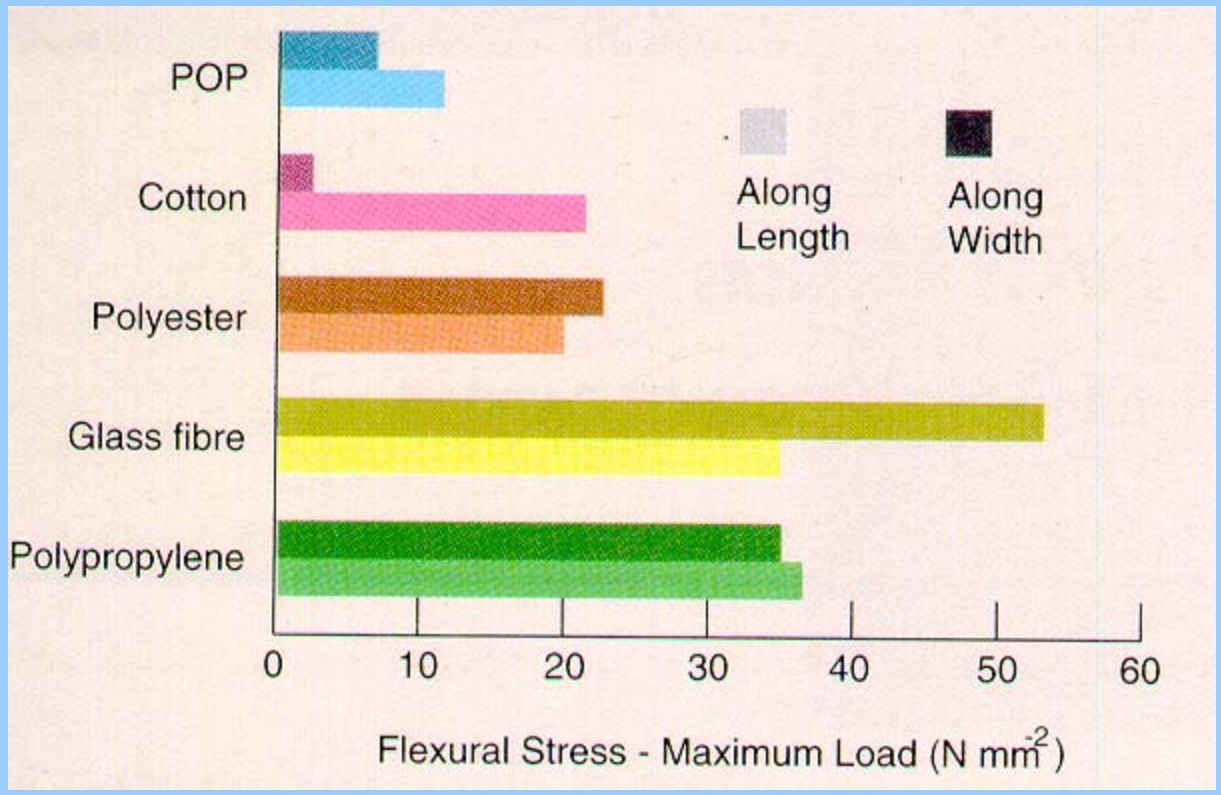
	Fabric Material
Glass Fibre	Fibre Glass
Nonglass Fibre	a. Cotton b. Polyester c. Polypropylene

Physical Properties

- Strength of POP and
- Synthetic Cast
  - Factors Affecting strength of POP
  - The Effect of Gauze on the Strength of POP
- Breaking of Below-Knee cast
- Consistency of Materials
- Deformation to Failure
- Water Immersion
- Vapour Permeability
- Stickiness
- Adhesiveness
- Conformability
- Friction
- Weight
- Wear
- Setting Properties
- Activation
- Recommendations

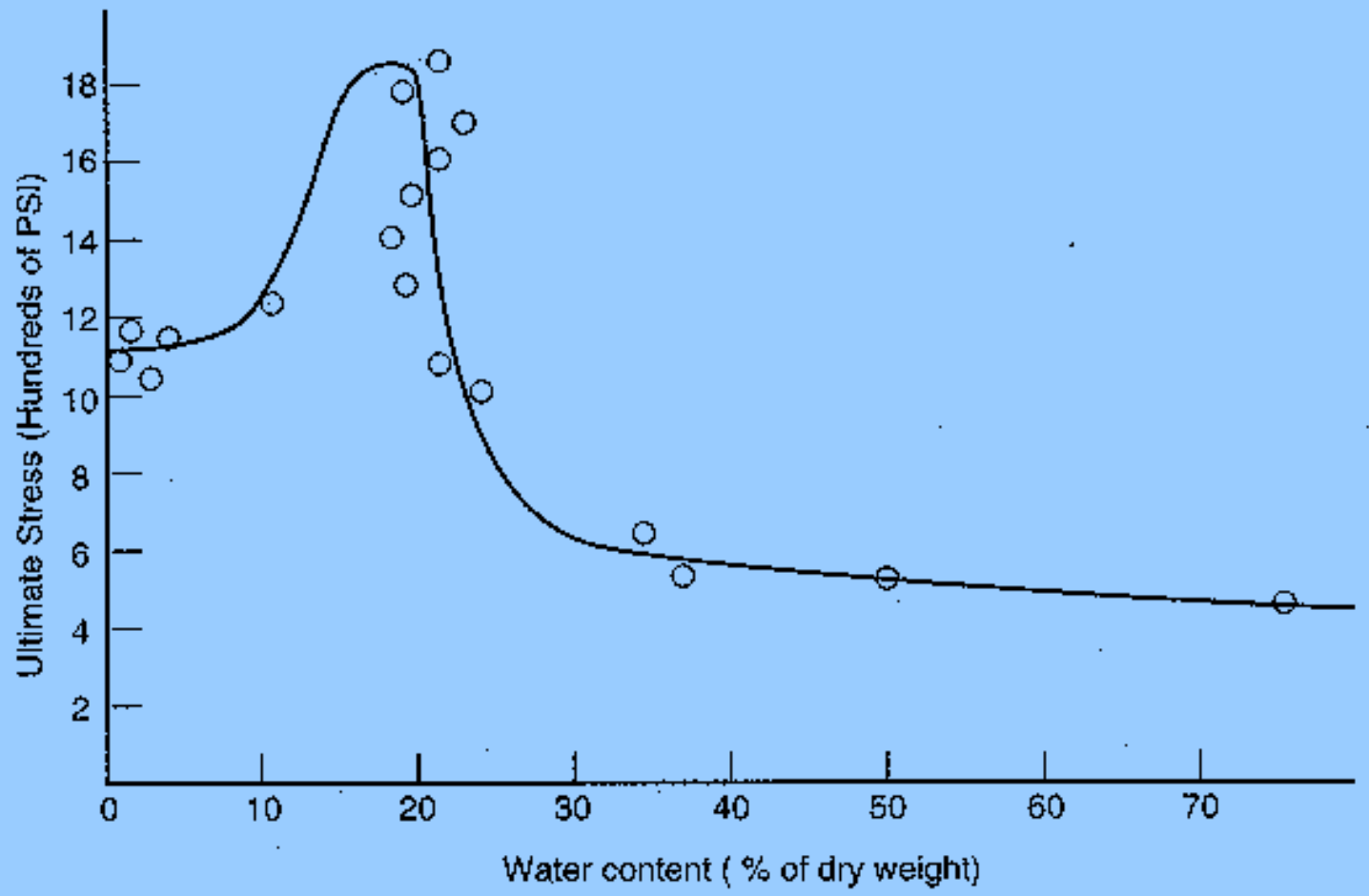
Strength of POP and Synthetic Cast

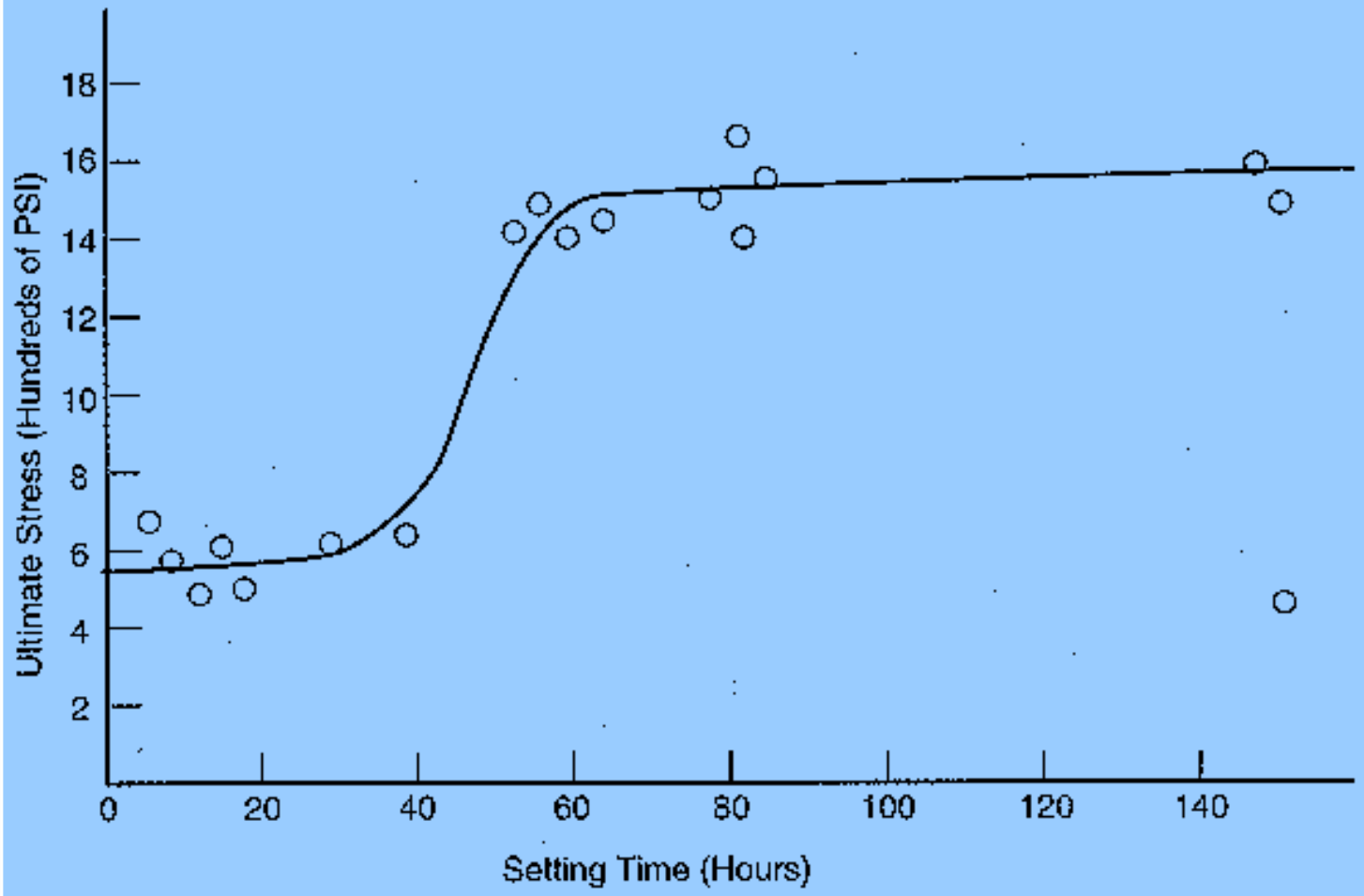
The strength of these materials is anisotropic



Factors Affecting Strength of POP

- Water Content
- Setting Time
- Temperature of Soaking Water


Ultimate Stress (Hundreds of PSI)
18
16
14
12
10
8
6
4
2
0
10
20
30
40
50
60
70
Water content (% of dry weight)


Ultimate Stress (Hundreds of PSI)
18
16
14
12
10
8
6
4
2
0
20
40
60
80
100
120
140
Setting Time (Hours)

Factors Affecting Strength of POP

- Water Content
- Setting Time
- Temperature of Soaking Water

The Effect of Gauze on the Strength of POP

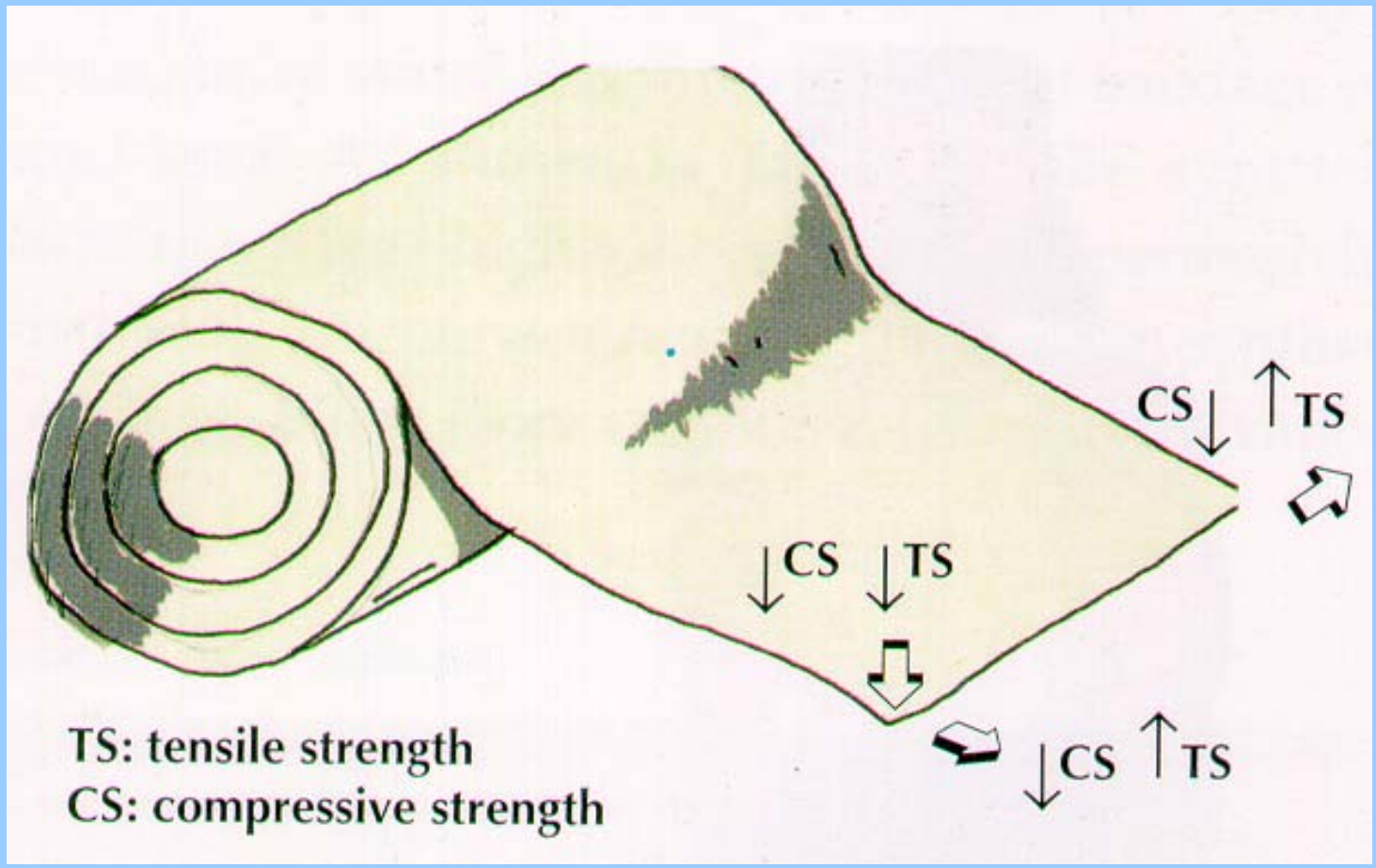


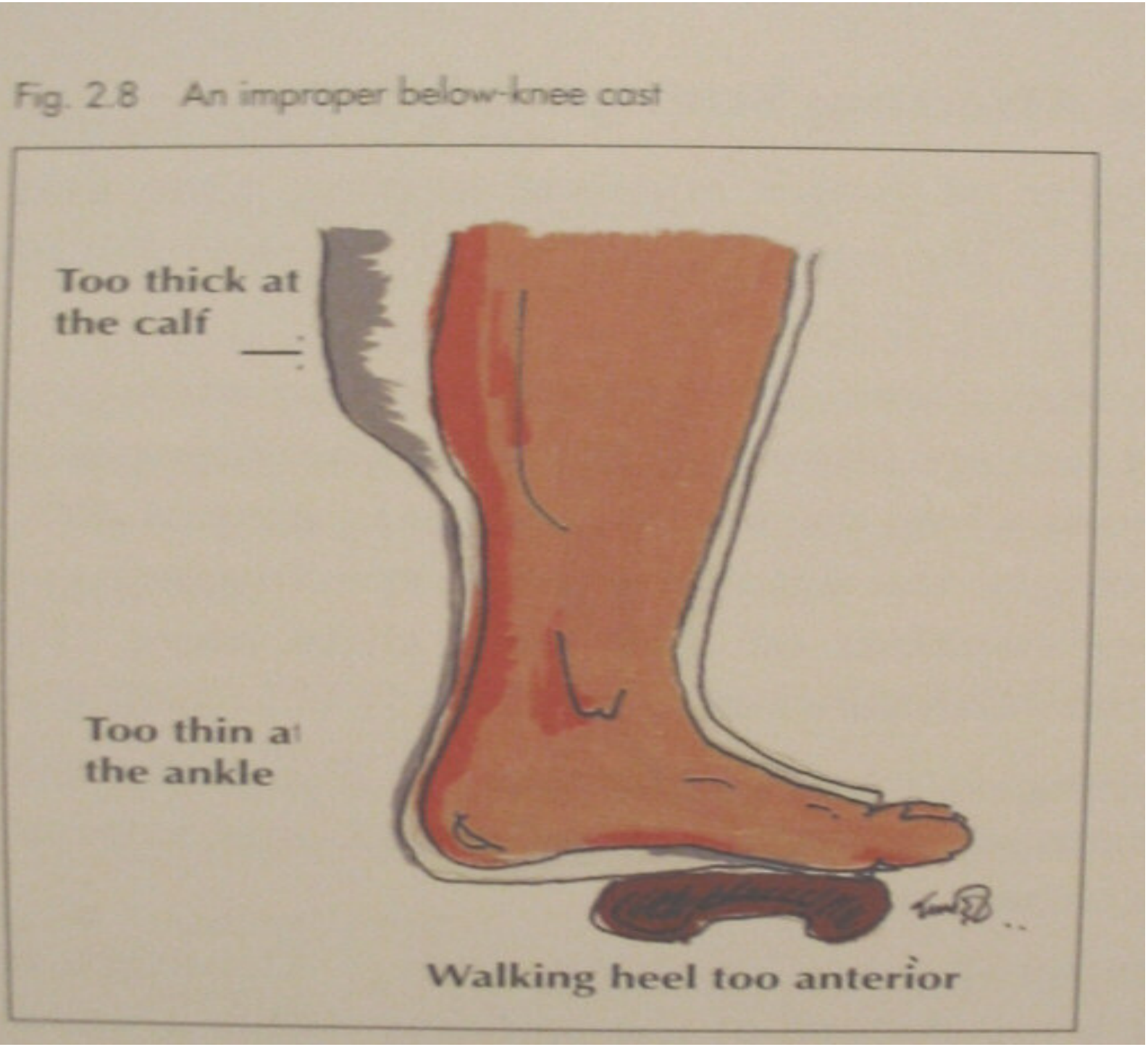

Fig. 2.7 Breaking of below-knee cast

Breaking of Below-Knee Cast

To reduce the chance of breaking

- Adequate setting time
- Thicker POP at ankle and thinner at calf or sole
- Position of walking heel
- Design of walking heel

Fig. 2.8 An improper below-knee cast

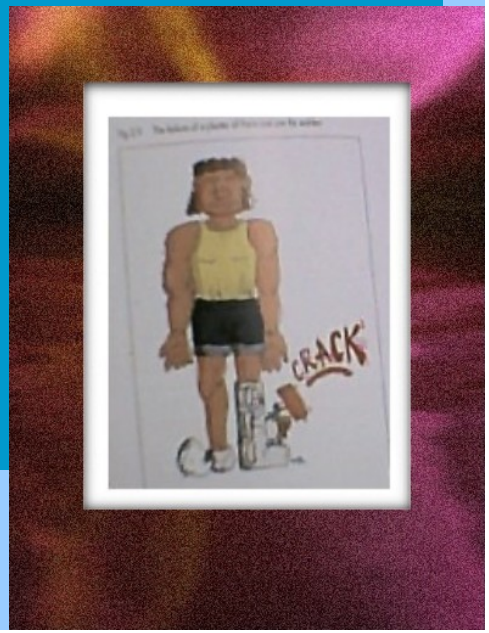


Consistency of Materials

POP is found to have a greater variability in strength than synthetic materials

Deformation to Failure

The deformation to failure of synthetic materials is usually gradual while that of plaster of Paris is usually sudden



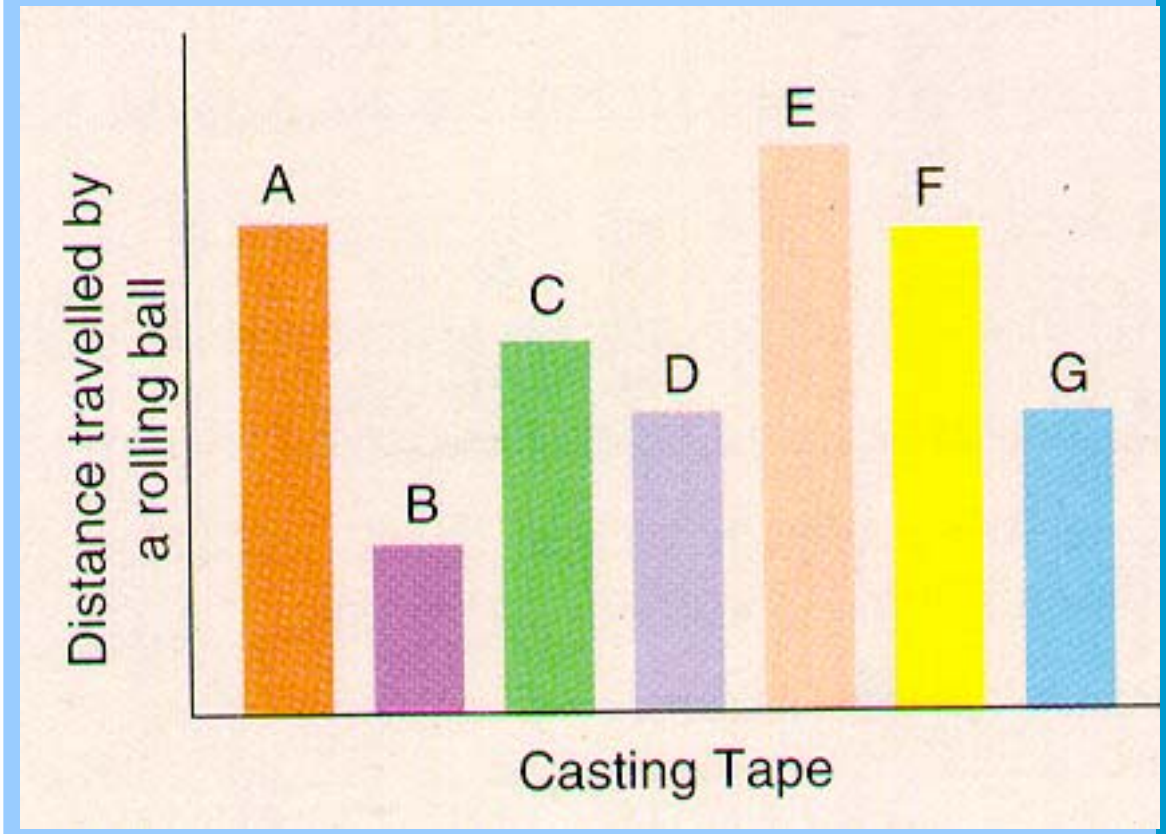
Water Immersion

POP casts deformed permanently after water immersion

Vapour Permeability

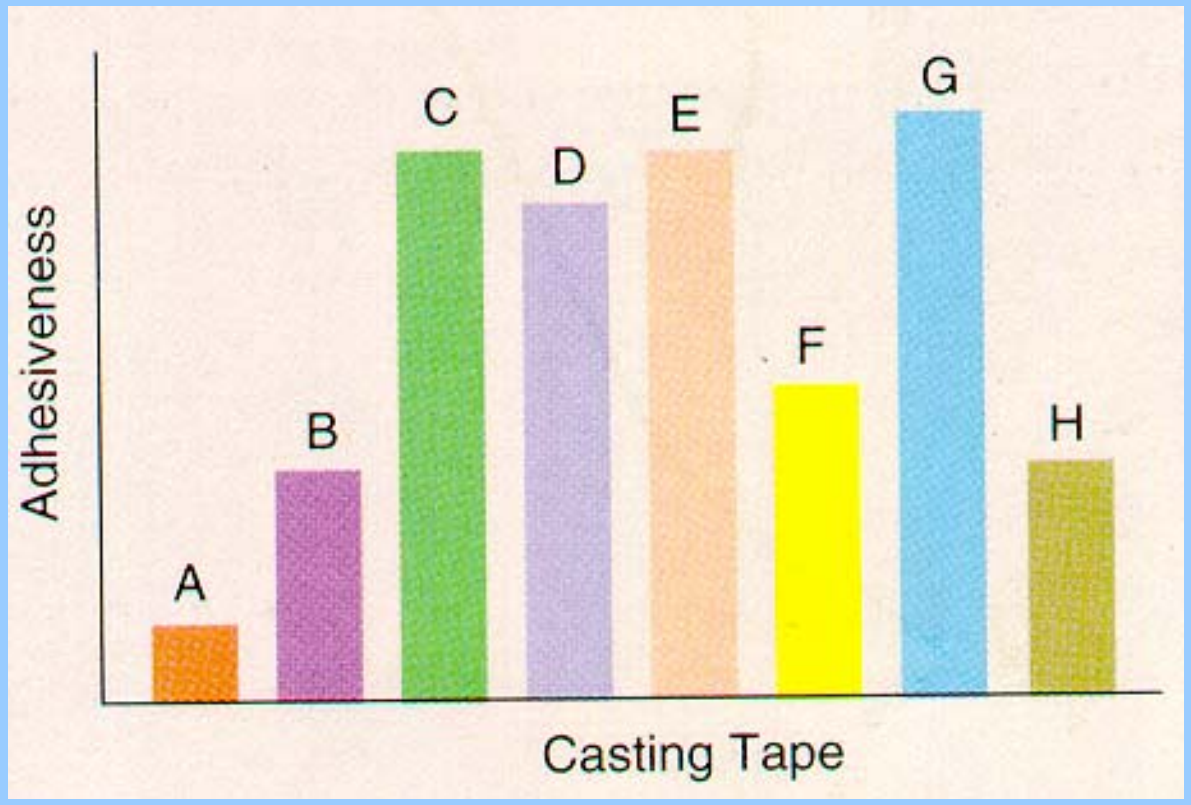
	Moisture Vapour Permeability ($mg/hr/m^2$)
POP	62.9
Glass fibre / resin 2	68.32
Glass fibre / resin 1	79.63
Polyester / resin	86.1
Cotton / resin	112.30

Stickiness



A. Deltacast
B. Deltalite
C. Deltalite S
D. Dynacast XR
E. Scotchcast Plus
F. Scotchflex
G. Zimflex

Adhesiveness



A. Deltacast
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F. Scotchflex
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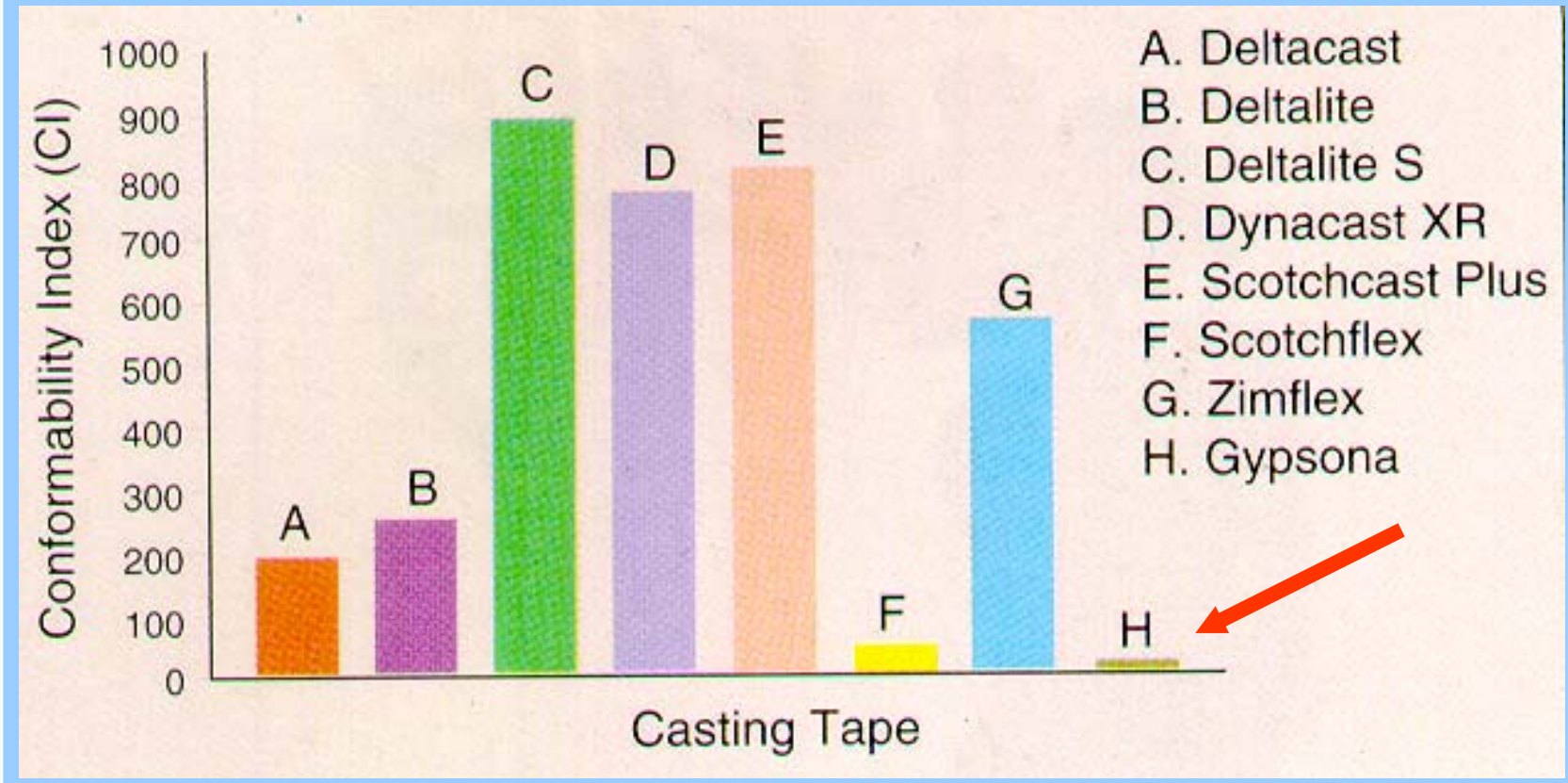
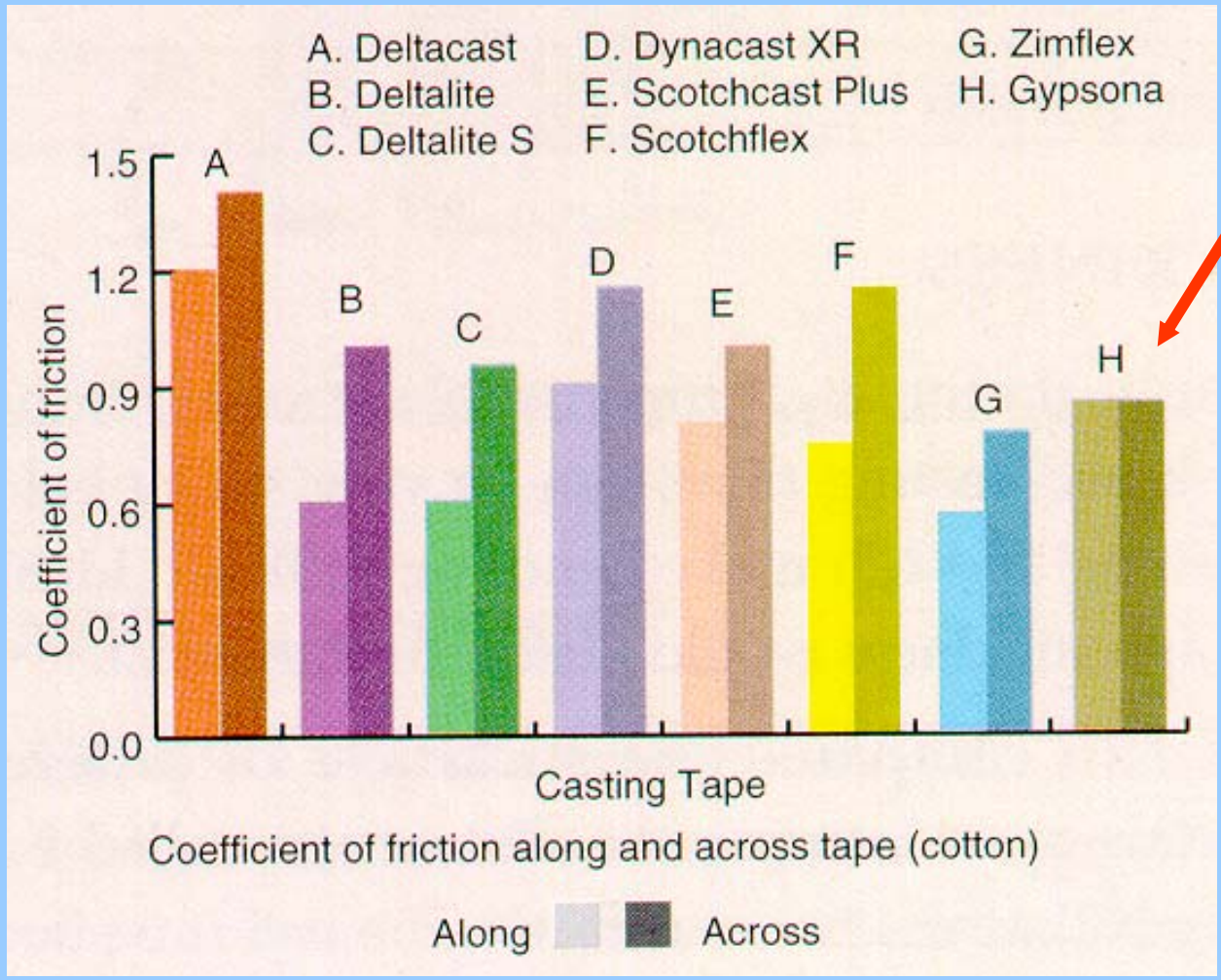
H. Gypsona

Conformability



Friction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E. Scotchcast Plus
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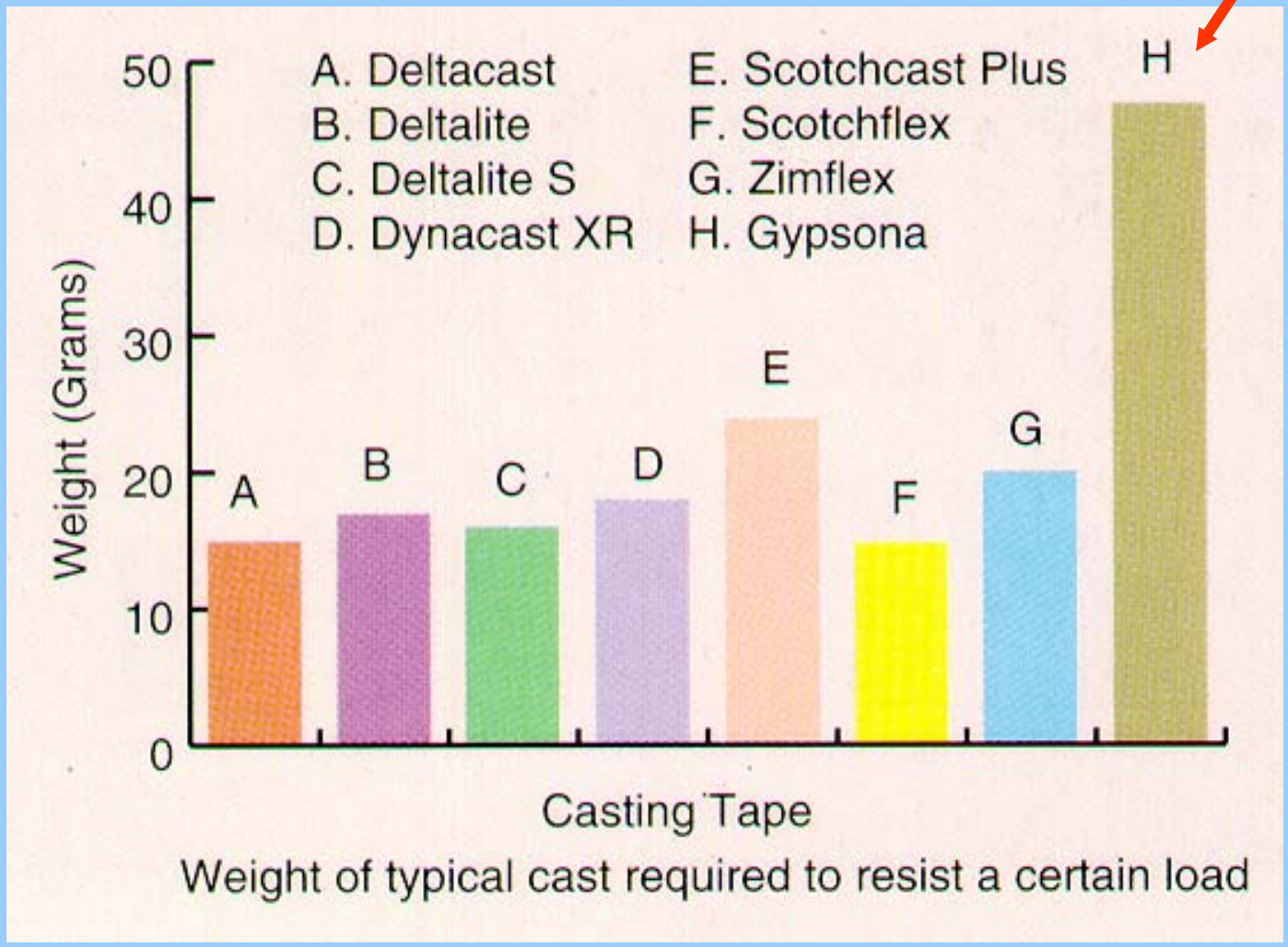
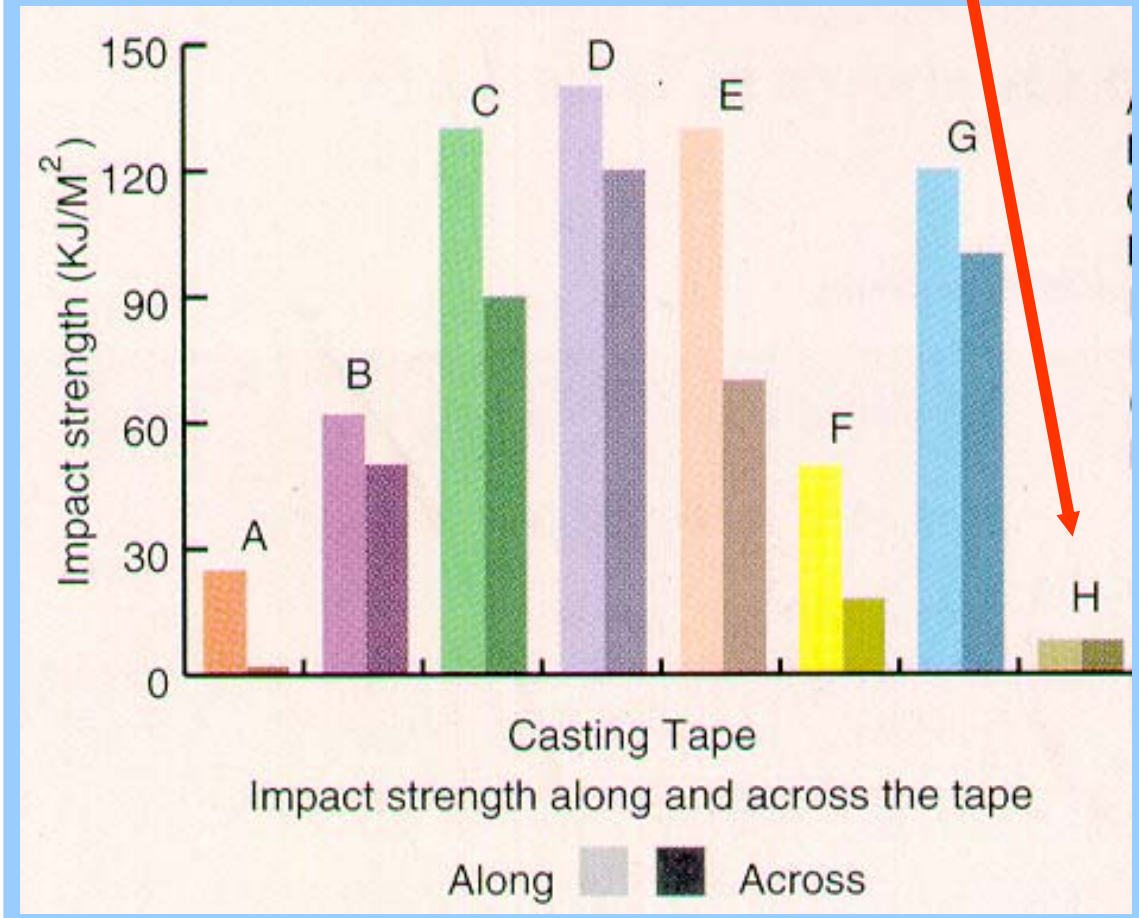
H. Gypsona
Coefficient of friction
1.5
1.2
0.9
0.6
0.3
0.0
A
B
C
D
E
F
G
H
Casting Tape
Coefficient of friction along and across tape (cotton)
Along
Across

Weight



Weight of typical cast required to resist a certain load

Wear



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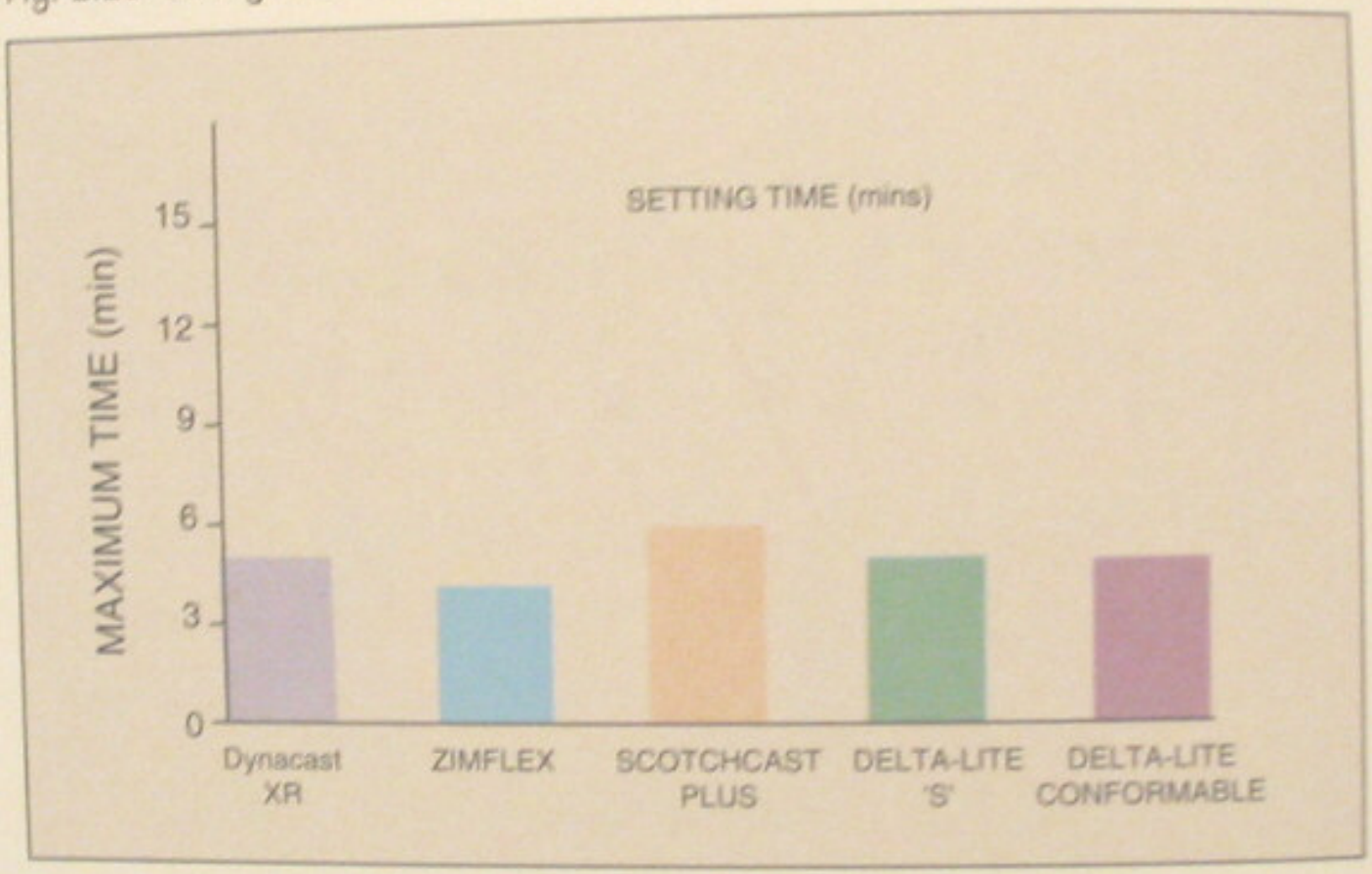
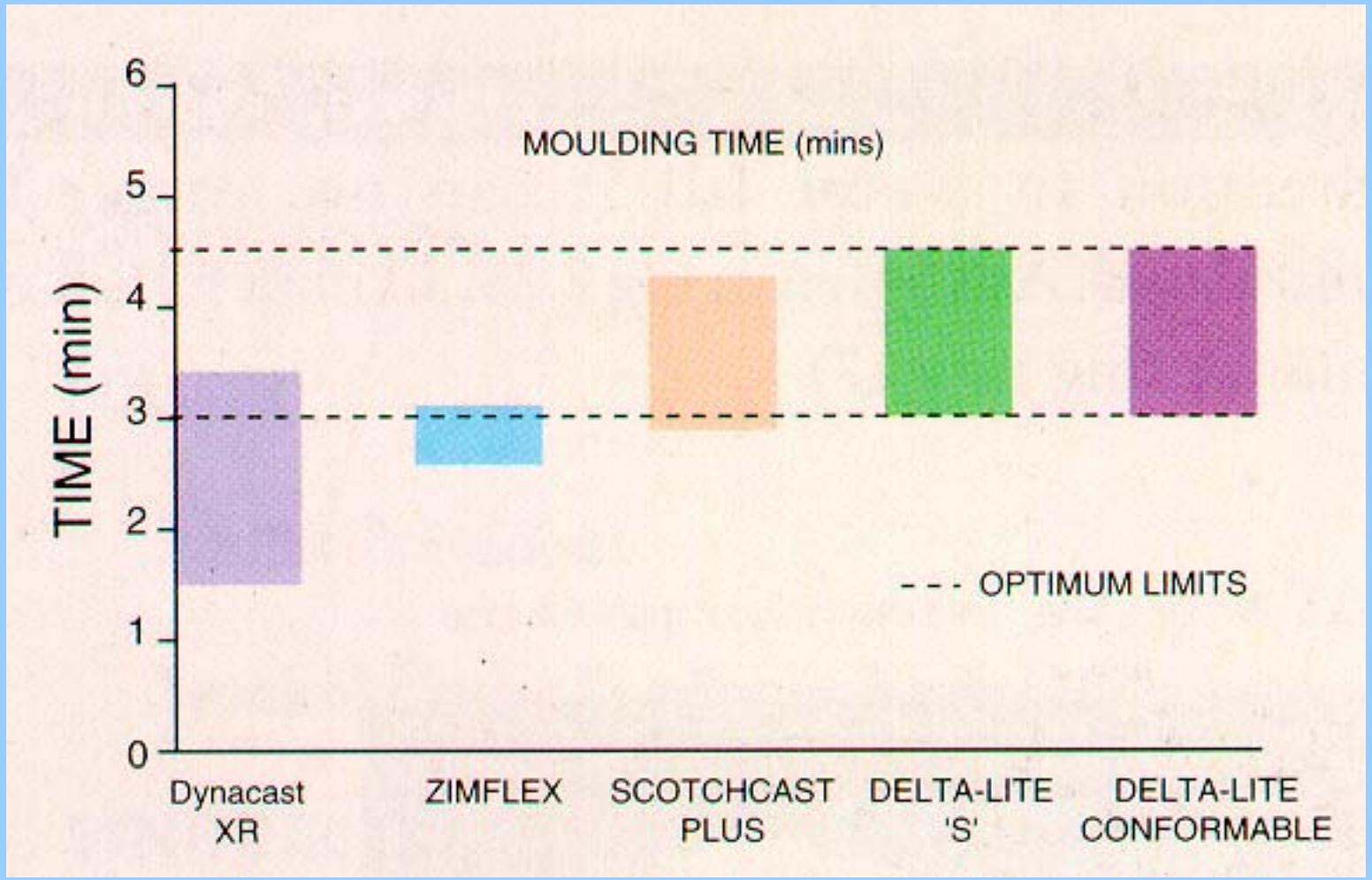
Setting Time

Fig. 2.28 Setting time



Setting Properties



Activation Recommendations

Delta-Cast	Immerse in cold water
Deltalite	Immerse in water at between 21°C and 27°C
Dynacast XR	Dip of 2-5s in warm water
Plaster-of-Paris	Dip for 10s in water of 20-25°C
Scotchast Plus	Dip in water at 21-24°C

Advantages of Non-fibre glass casting materials over Fibre-glass

- Lighter
- More X-ray lucent
- Less sharp edges
- No carcinogenic dust

Price differential per cast

Non-fibre glass	Fibre-glass	POP
3.5	2.5	1

HAPPY LEARNING