

# **CEL 774 CONSTRUCTION PRACTISES**

## ***Mix design of Concrete: General Principles***

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# ***General Outline***

- **Specifying concrete for a given application**
- **The Mix design Procedure**
- **Mix design Method**



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# WHAT ARE THE OBJECTIVES OF MIX DESIGN?

- To find a combination of constituents that would give concrete of properties complying with certain specifications, economically .**
- Characteristics of the concrete those satisfy the needs are the properties at fresh and hardened states**
- These properties are selected depending on the application and expected performance.**



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# Specifying Fresh concrete

## ➤ *Fresh Concrete Properties*

### ➤ *Slump, Ve-be or Compaction factor Test*

■ *The method of placing, section dimension and amount reinforcement etc, decides the above property requirement. e.g. slump:*

❖ *Shallow section: very low; Mass concrete, lightly reinforced beam: low, 25-75 mm; Heavily reinforced beam: 50-100mm; Pumped concrete: 100-150 mm.*



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# **Specifying hardened concrete**

## ***–Hardened Concrete Properties***

- ❖ ***Grade & compressive strength at required age***
- ❖ ***Tensile strength appropriate age***
- ❖ ***Durability requirements in terms of minimum cement content maximum w/c and minimum grade of concrete***



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# ***Other specification/information***

- ❑ ***m.s. a, rounded/crushed aggregate grading, grading zone/FM (locally available). Specific gravity of aggregate***
- ❖ ***Type of cement and cement strength.***
- ***Type of admixtures***
- ⊗ ***Absorption of aggregate and moisture content.***
- ⊗ ***Degree of QC (Standard Deviation)***



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# ***Fixing concrete Specifications***

- Recommendations of relevant standards***
- Realistic, non-conflicting specifications***
- Consultation amongst all involved***
- Previous experiences***



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# CONCRETE PROPERTIES

## *Fresh Concrete Properties*

- *Depends on water content*
- *Grading of the aggregate (packing Characteristics) and m. s. a*
- *Shape of aggregate*



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# CONCRETE PROPERTIES

## *Hardened Concrete Properties*

- *Strength: mainly governed by  $w/c$  or  $w/(c+F)$*

*All other mechanical properties are related to compressive strength.*

## *Long-term Concrete Properties*

- *Durability is controlled through  $w/c$  or  $w/(c+F)$ , cement content & grade of concrete*



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# THE MIX DESIGN PROCEDURE

*Minimum cost satisfying the specifications*

- *Optimization Problem*
- *Well defined mathematical relationship not available*
- *Empirical Formulae and experience*

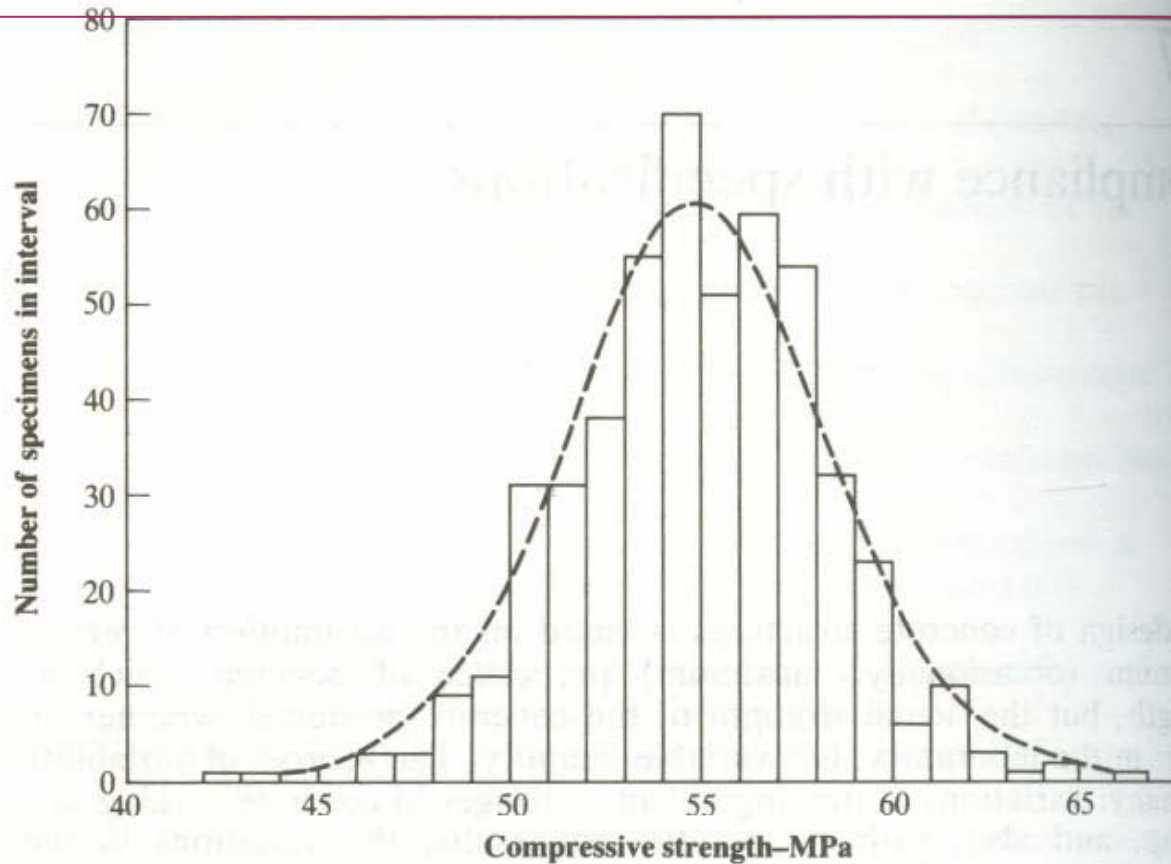
*The Science & Arts of Mix design*



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# Nature of strength variations



- **The variation is normally Distributed population**
- **Average represents mean**
- **SD measures dispersion**



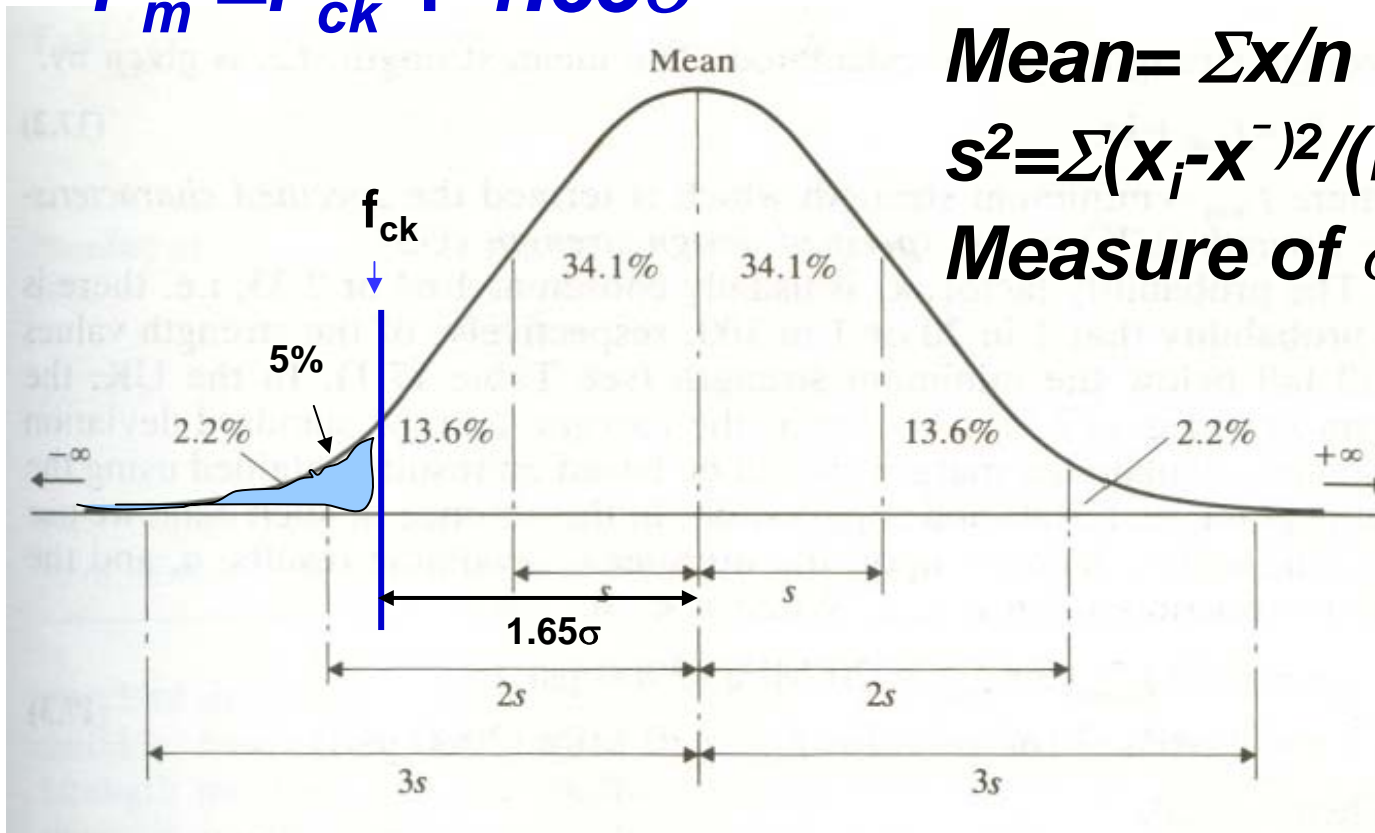
# Mean Strength

$$f_m = f_{ck} + 1.65\sigma$$

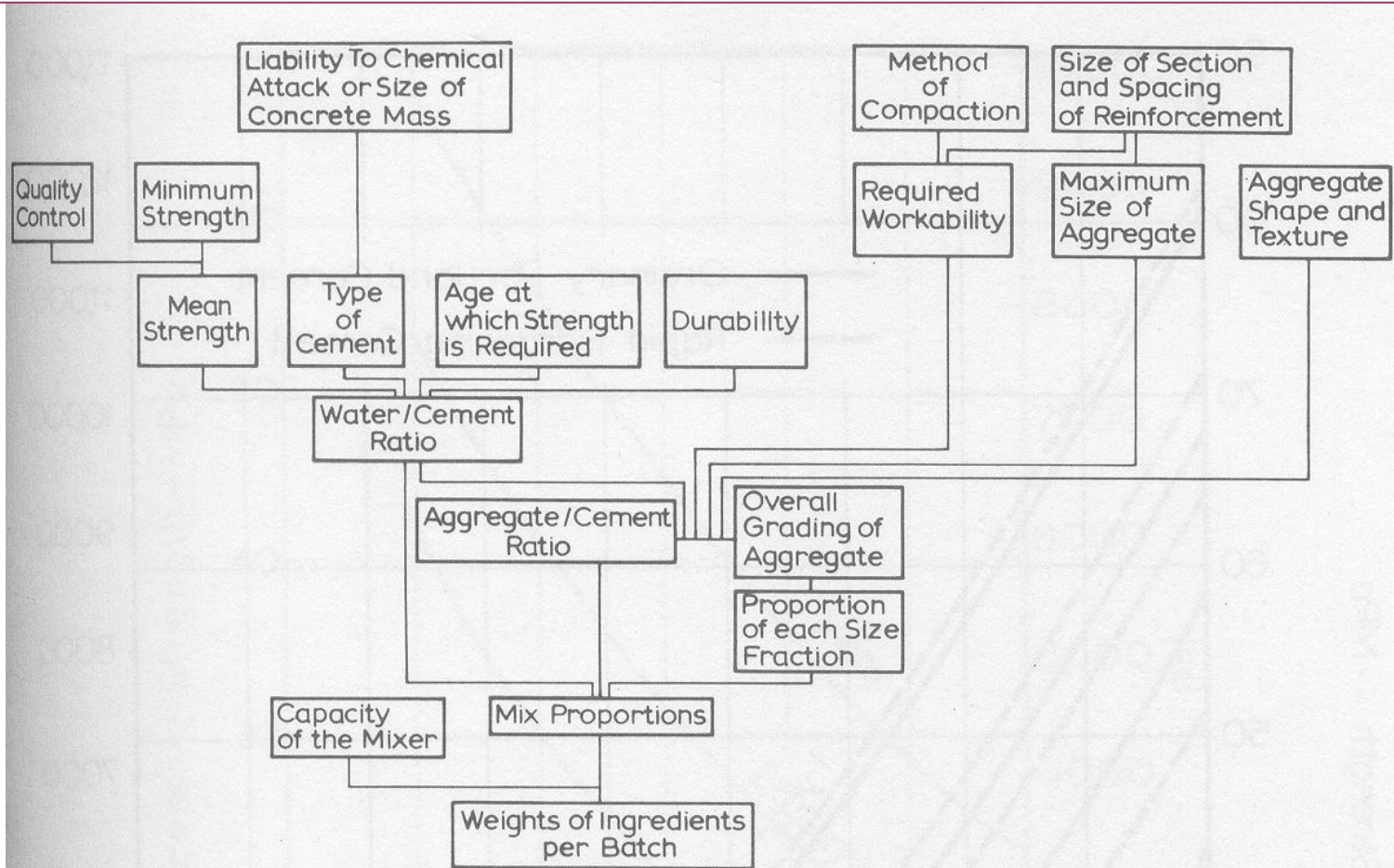
$$\text{Mean} = \Sigma x/n$$

$$s^2 = \Sigma (x_i - \bar{x})^2 / (n-1)$$

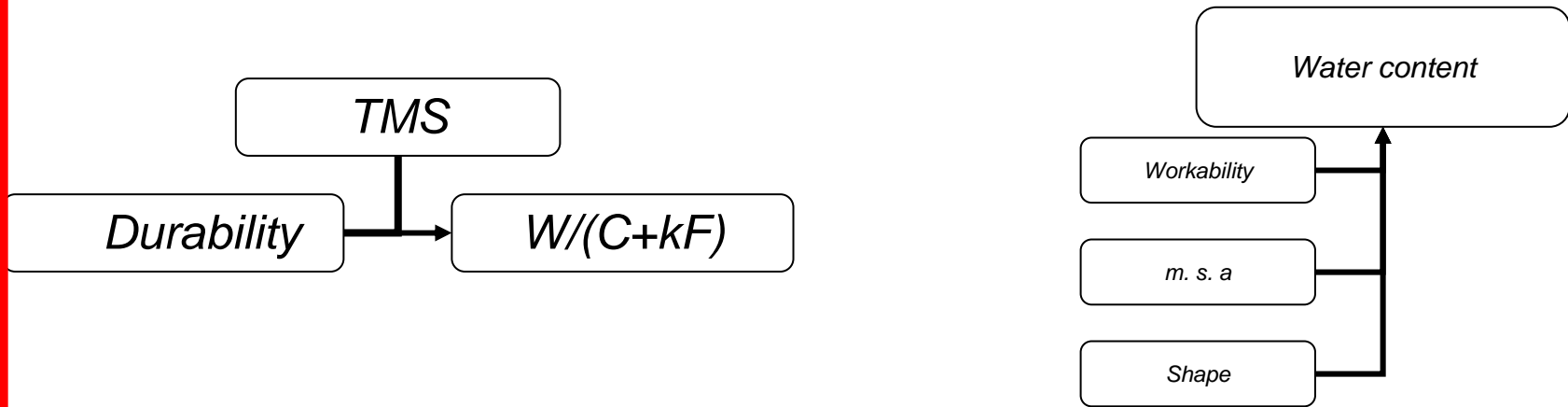
$$\text{Measure of } \sigma = s$$



# Mix design process



# THE MIX DESIGN PROCESS



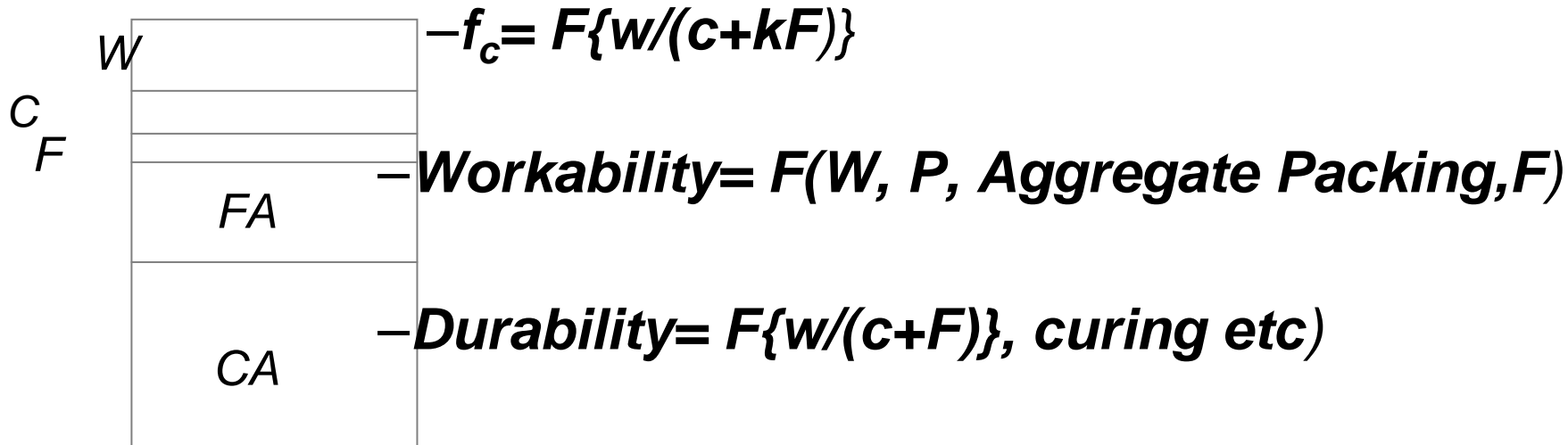
- *w/c and W known, c can be calculated*
- *Total aggregate content is calculated, assuming conservation of volume & fine content is calculated from fine/coarse ratio*



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# The mix design process



*-Total volume is conserved*



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# THE MIX DESIGN PROCESS

❖ ***Making trial Batches and re-optimization:  
Specified property must be measured  
on a trial batch to verify***

● ***Final Adjustments***

⚖ ***Yield : Correct content per unit volume  
for economic evaluation***



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# ***Methods***

***– Since empirical, hence no unique method.***

***□ IS method.***

***❖ British DOE method.***

***➤ ACI 211.1 METHOD.***



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# ***Summary***

***Specifications & inputs for mix design***

***General process***

***Methods***



***THANK YOU FOR  
HEARING***



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