

Reinforced Concrete Design

Safety Context

Organized by

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Mirpur, Dhaka

DISCUSSION TOPICS

- SAFE STRUCTURAL DESIGN

&

- SAFE CONSTRUCTION

OUTCOME

AFTER ATTENDING OF THIS DISCUSSION PROGRAM,
YOU WILL:

- BE ACQUINTED WITH A LARGE COMMUNITY TO DISCUSS YOUR ISSUES IN FUTURE;
- UNDERSTAND COMMON MISTAKES IN DESIGN OF RC STRUCTURE;
- GET SOME IDEA ON ADVANCE STRUCTURAL DESIGN PROCEDURE;
- UNDERSTAND KEY POINTS FOR GOOD CONSTRUCTION;

BEFOR WE START

- NONSENSE ARE MORE HAPPY -
[বোকারা তিন বার হাসে।]

LESSON 1

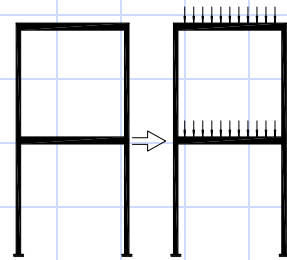
- DESIGN STARTS BEFORE CALCULATION
&
- DESIGN STARTS AFTER CALCULATION

THINK DIFFERENT ?

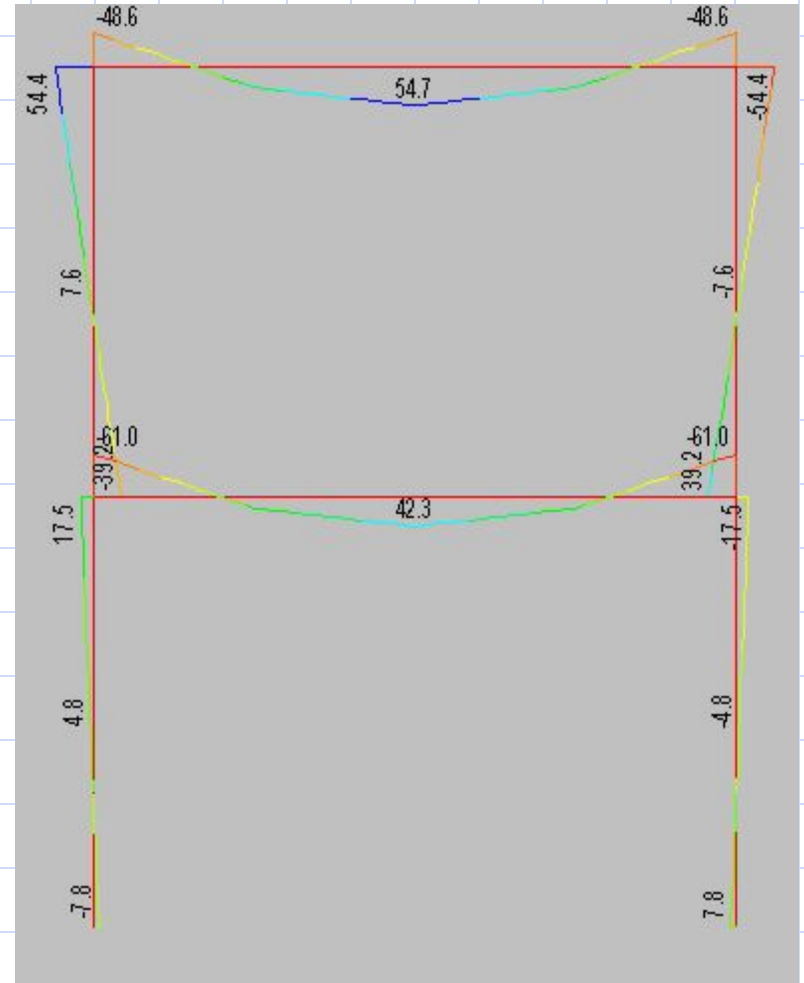
- WE ASSUME THE STRUCTURE AS A WHOLE EXIST AT ANY INSTANCE OF TIME AND ALL LOADS ACTS AT THE SAME TIME INSTANCE
- IN REALITY IT NEVER HAPPENS SO
- NOT ONLY STRUCTURE, STRENGTH OF MATERIAL GROWS OR DEVELOP WITH TIME

MAY BE "TIME" IS A FACTOR THAT WE NEED TO CONSIDER IN DESIGN

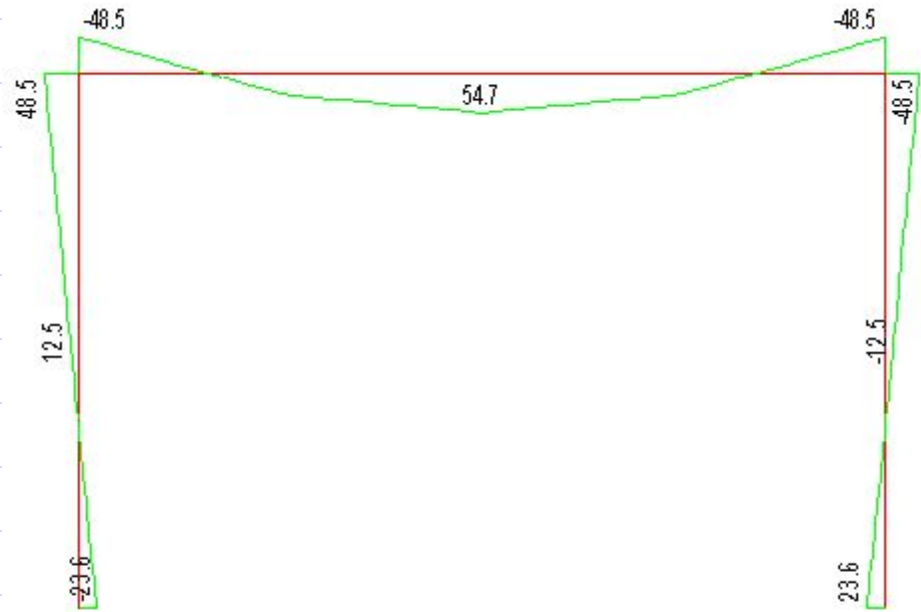
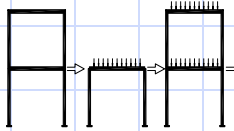
A simple example



Conventional analysis

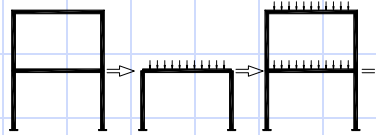


A simple example

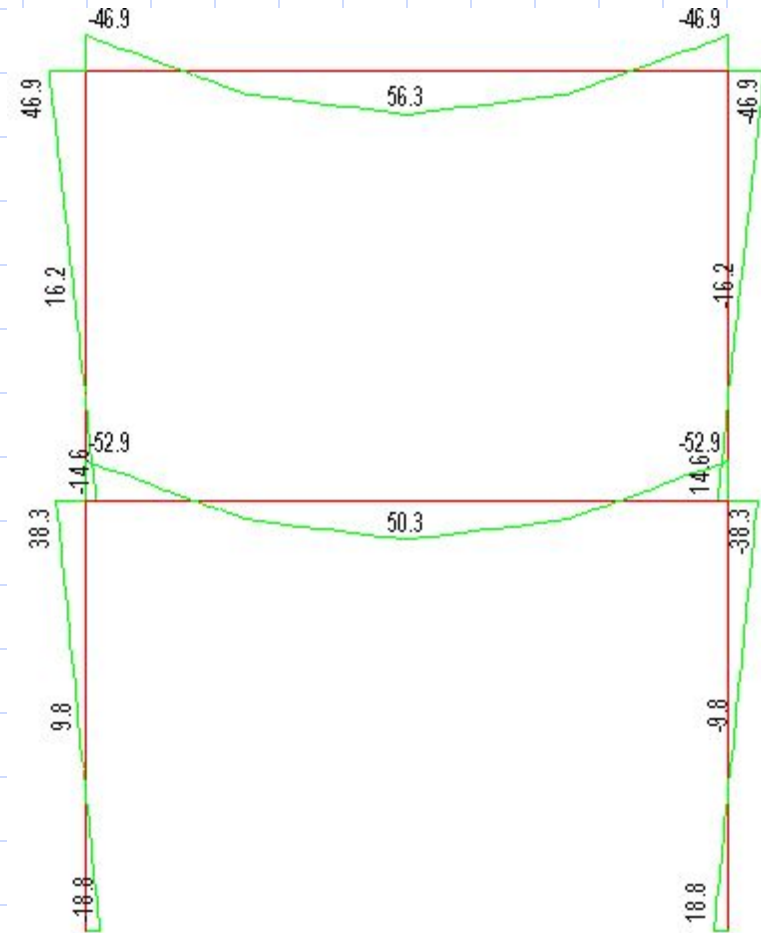


Construction stage analysis –
Stage 1

A simple example



Construction stage analysis – Stage 2



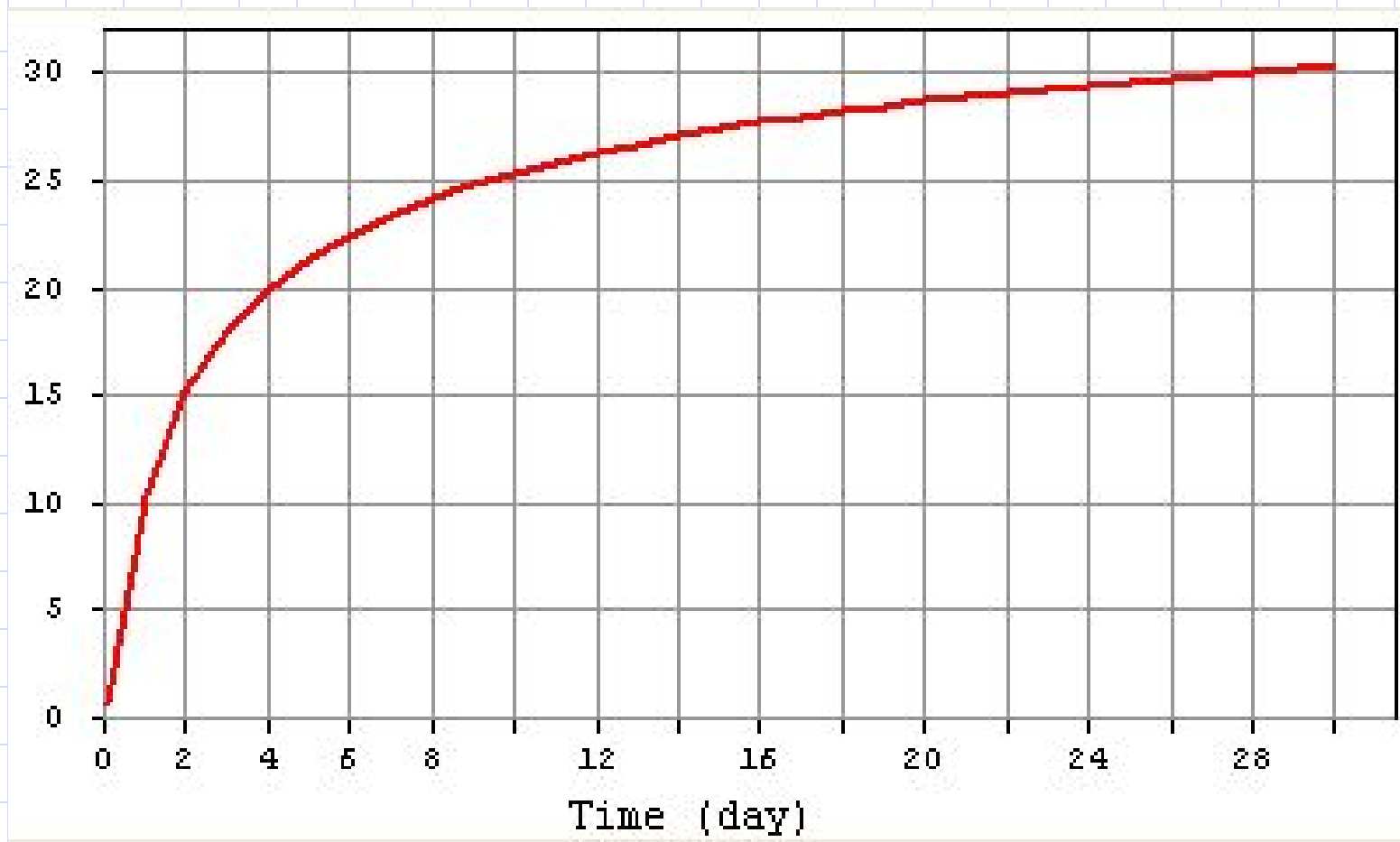
A Comparison Between Conventional and Construction Stage Analysis

Description	Bending moment				Displacement	
	1 st Stage column (upper end)	1 st Stage beam (middle)	2 nd Stage column (upper end)	2 nd Stage beam (middle)	1 st Stage beam (middle)	2 nd Stage beam (middle)
Construction stage analysis	38.3	50.3	46.9	56.3	3.77	3.4
Conventional analysis	17.5	42.3	48.6	54.7	2.28	3.35
Ratio	219%	119%	97%	103%	165%	101%

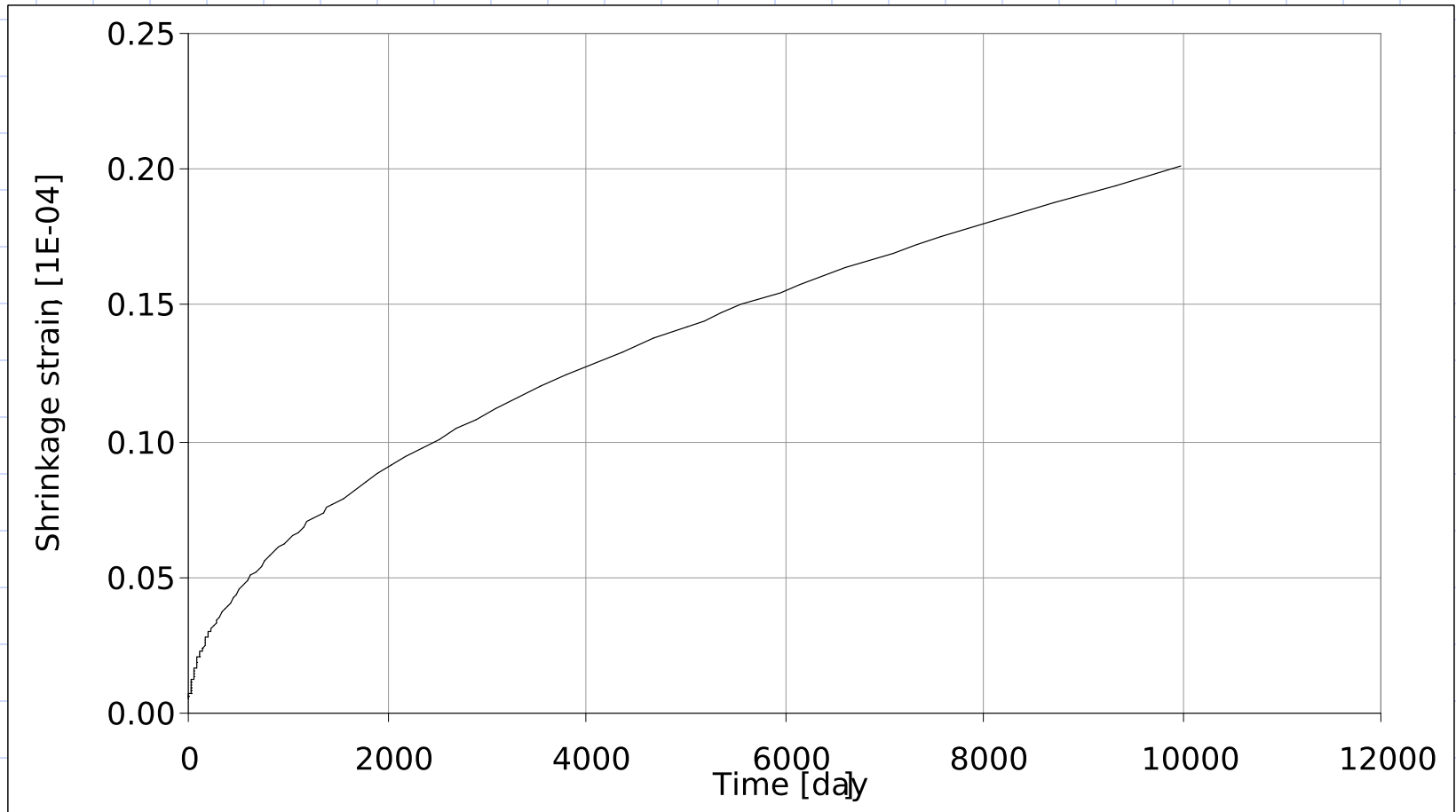
What are the additional with Time?

- Load and Structural Elements as per construction sequence
- Time dependent material property
- Compressive Strength
- Shrinkage
- Creep

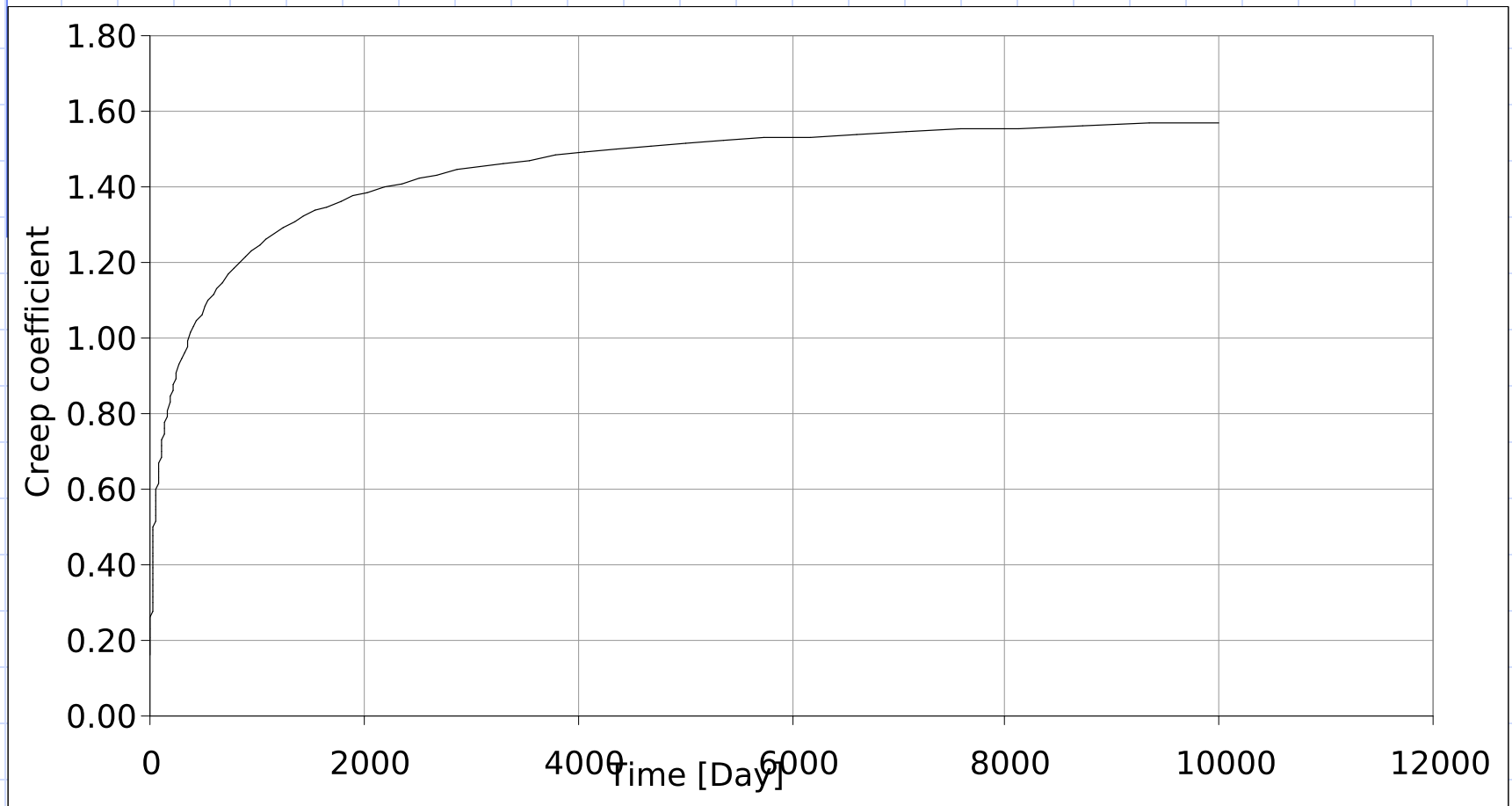
Development of COMPRESSIVE Strength of Concrete with TIME



Development of SHRINKAGE Strain of Concrete with TIME



CREEP Coefficient of Concrete



WHAT ARE COMMON AMONG THE PRACTICING ENGINEER?

- TOO DEPENDENT ON SOFTWARE FOR DESIGN OF STRUCTURAL MEMBERS.
- DO NOT UNDERSTAND MATERIAL SPECIFICATION.
- DO NOT UNDERSTAND CONTRACT.
- CAN NOT WRITE REPORTS.

COMMON MISTAKES WE DO IN FOUNDATION DESIGN

- SOIL INVESTIGATION - WE NEVER SAY WHAT TO INVESTIGATE.
- WE SELDOM CONSIDER WATER TABLE IN FOUNDATION DESIGN.
- WE NEVER CONSIDER SURCHARGE LOAD FROM GR. FLOOR ON FOUNDATION.
- WE NEVER CALCULATE SETTLEMENT.

BEAM DESIGN

- TORSION IS AN IMPORTANT ISSUE BUT USUALLY NOT CONSIDERED IN RC DESIGN – BECAUSE GENERAL PURPOSE ENGINEERING SOFTWARE ONLY CONSIDER STRONG AXIS MOMENT/SHEAR FOR RC DESIGN. – **THIS IS A GREAT MISTAKE.**
- CHECK REINFORCEMENT DETAILING AT JOINTS.
- CHECK CRACK WIDTH.

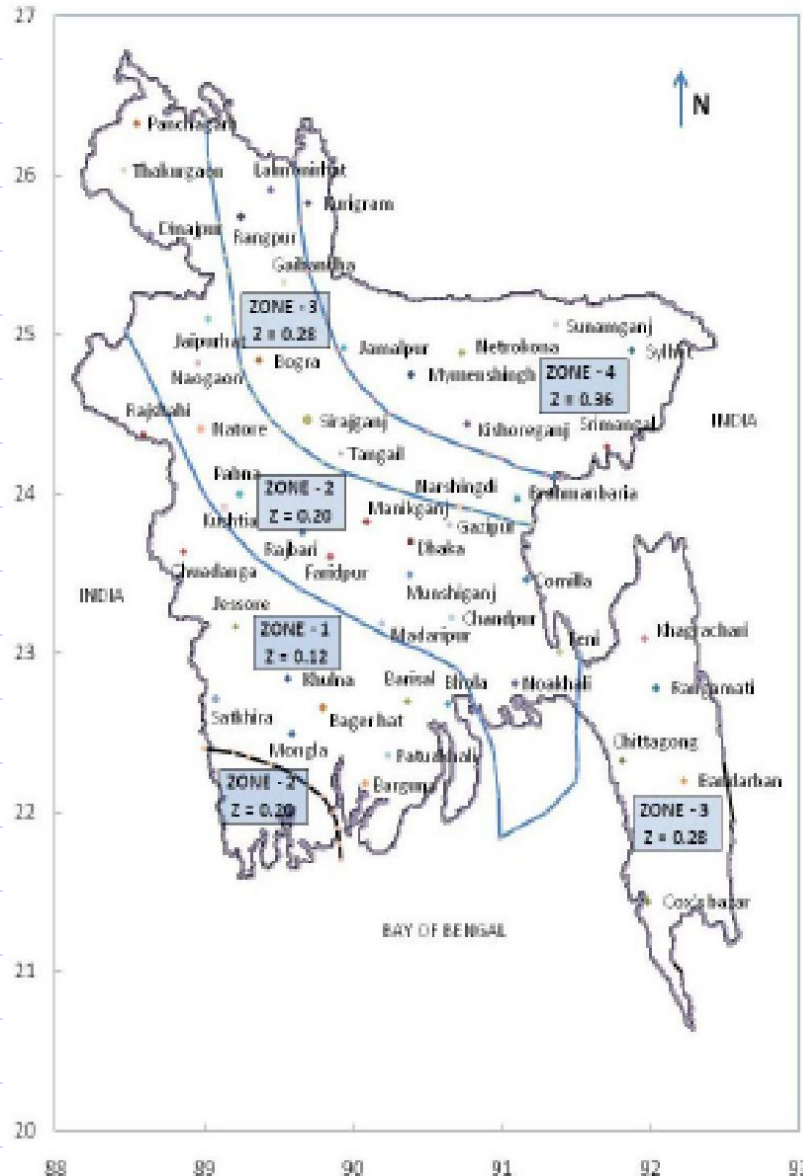
COLUMN DESIGN

- COLUMN FAILS IN SHEAR DURING EARTHQUAKE – COMMON PRACTICE IS TO DESIGN COLUMN FOR AXIAL FORCE AND MOMENT ONLY.
- WHAT ABOUT MOMENT MAGNIFICATION IN COLUMN DESIGN? OR OTHERWAY TO CONSIDERE GEOMETRIC NON-LINEARITY?
- DID YOU KNOW- STIFFNESS OF THE STRUCTURE REDUCE FOR AXIAL COMPRESSION?

LOADS IN BUILDING

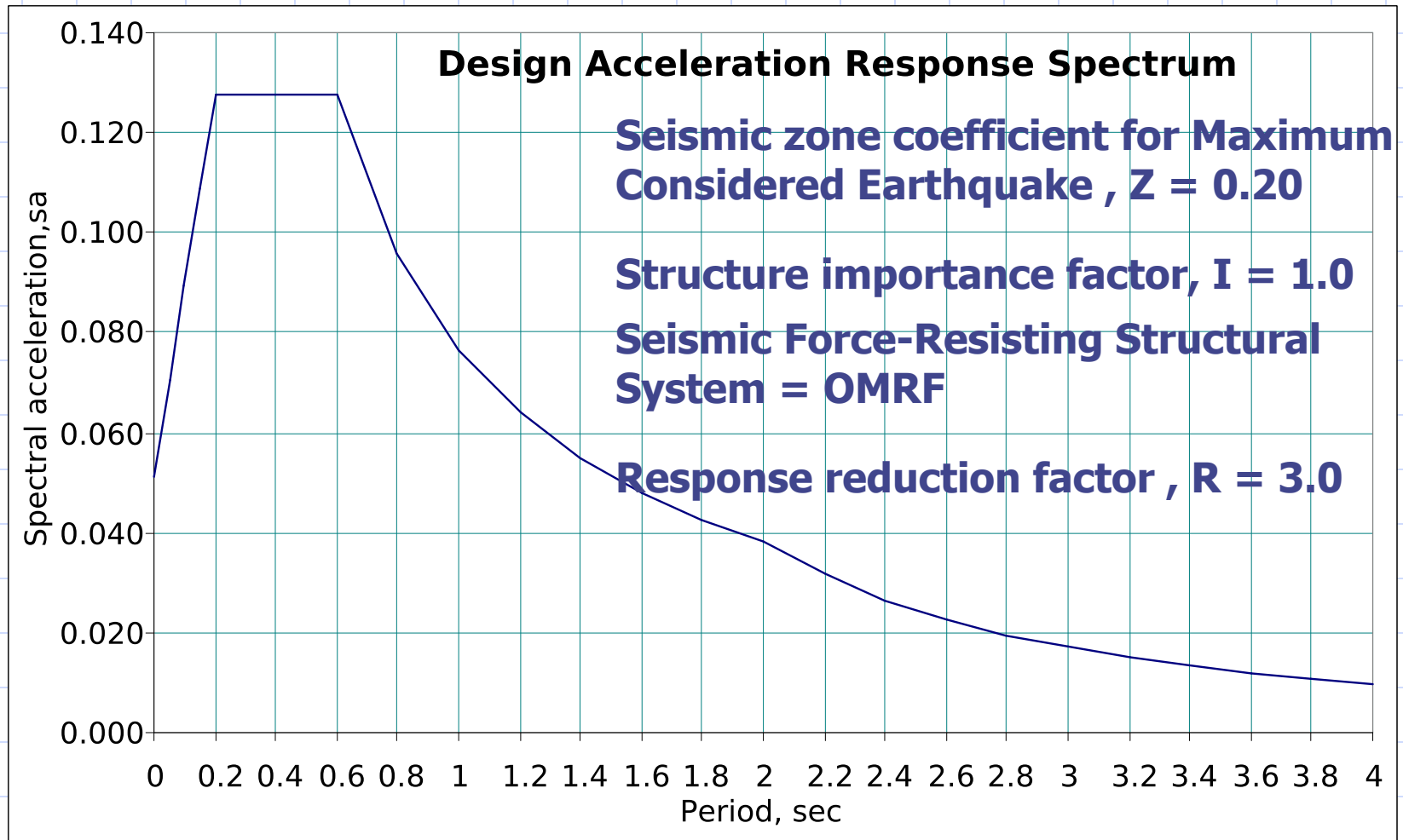
- WE HAVE FAIRLY GOOD UNDERSTANDING OF PERMANENT GRAVITY LOADS (DEAD & LIVE).
- WE HAVE LESS UNDERSTANDING ON ENVIRONMENTAL LOAD e.g. WIND & EARTHQUAKE.
- WE HAVE NO UNDERSTANDING ON SECONDARY LOADS e.g. CREEP, SHRINKAGE.
- DID YOU KNOW, FOUNDATION SETTLEMENT IS A LOAD THAT NEED TO BE CONSIDERED IN DESIGN?

EARTHQUAKE LOAD



- BETTER WAY TO INPUT EARTHQUAKE LOAD IS AS – RESPONSE SPECTRUM FUNCTION.
- IT CONSIDERS THE DYNAMIC MODE SHAPES OF THE BUILDING.
- EASY TO INPUT – IF YOU HAVE LITTLE UNDERSTANDING ON STRUCTURAL DYNAMICS.

EARTHQUAKE LOAD

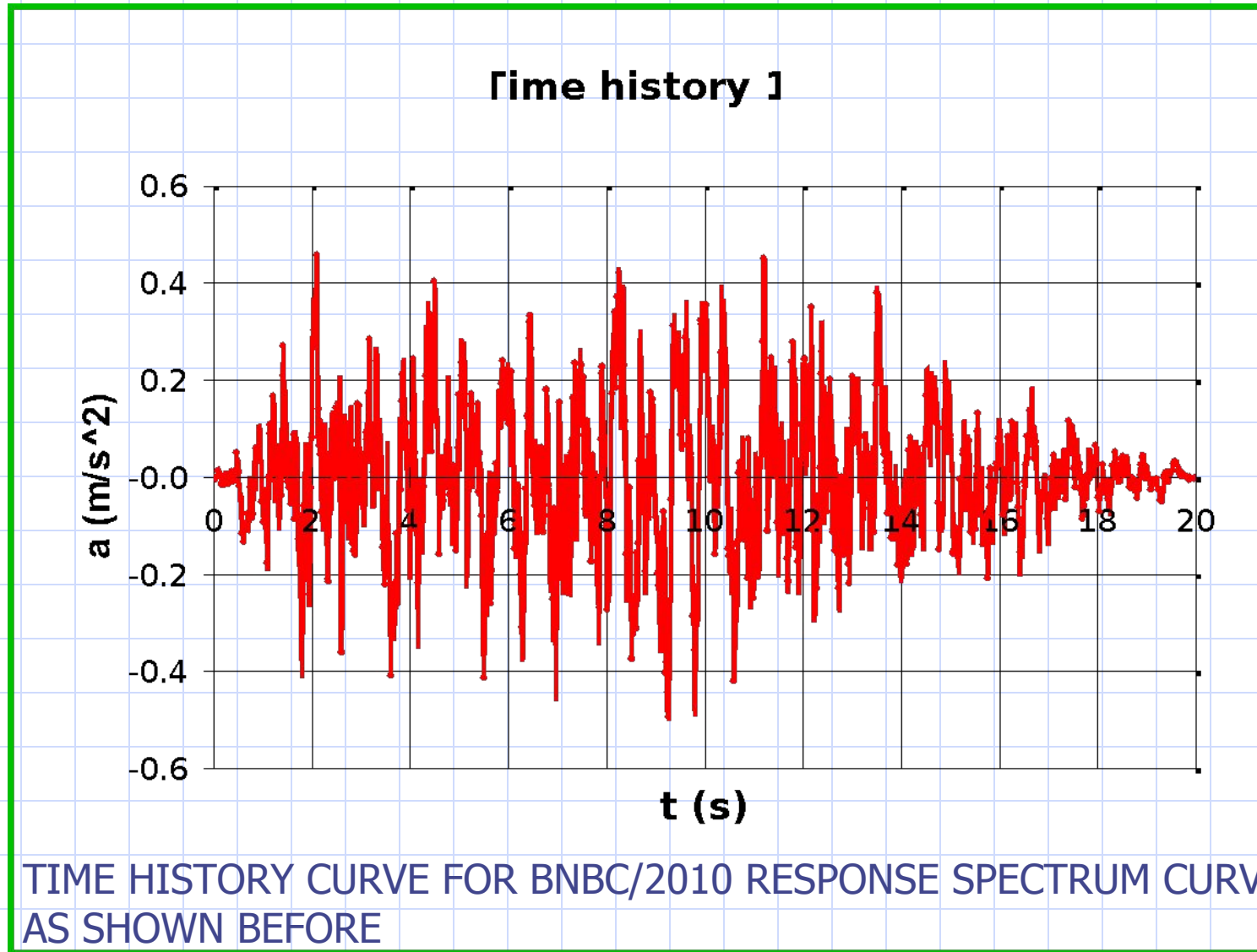


A TYPICAL RESPONSE SPECTRUM CURVE AS PER BNBC/2010

EARTHQUAKE LOAD

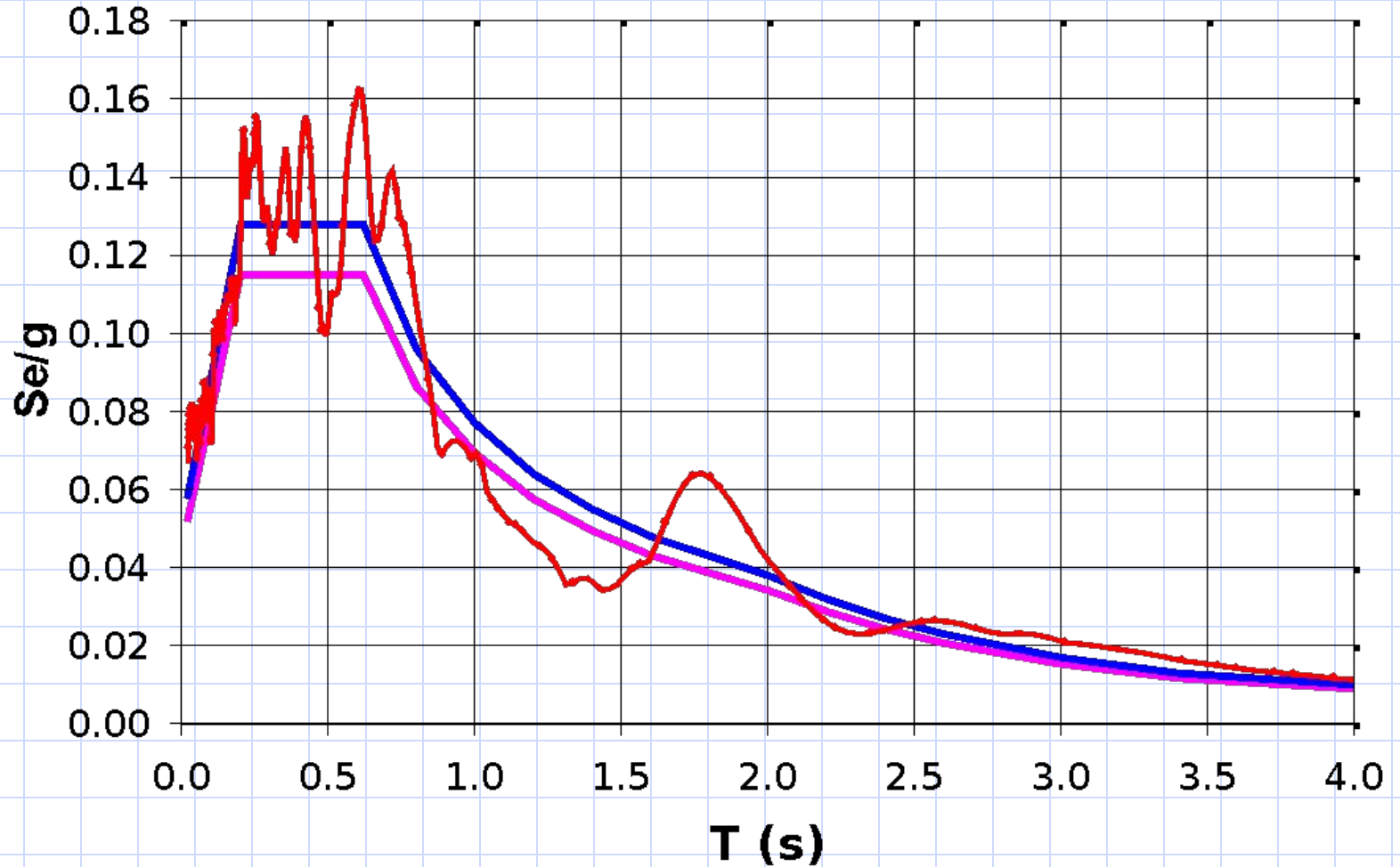
- IF WE ARE LITTLE COURAGEOUS – WHY NOT USE 'TIME HISTORY DATA' FOR OUR BUILDING ANALYSIS ?
- WE CAN GENERATE A RESPONSE SPECTRUM COMPITABLE TIME HISTORY DATA WITH LITTLE EXPERTISE IN NUMERICAL MATHEMATICS.

EARTHQUAKE LOAD



EARTHQUAKE LOAD

Response Spectrum



TIME HISTORY DATA MATCHING TARGET SPECTRUM

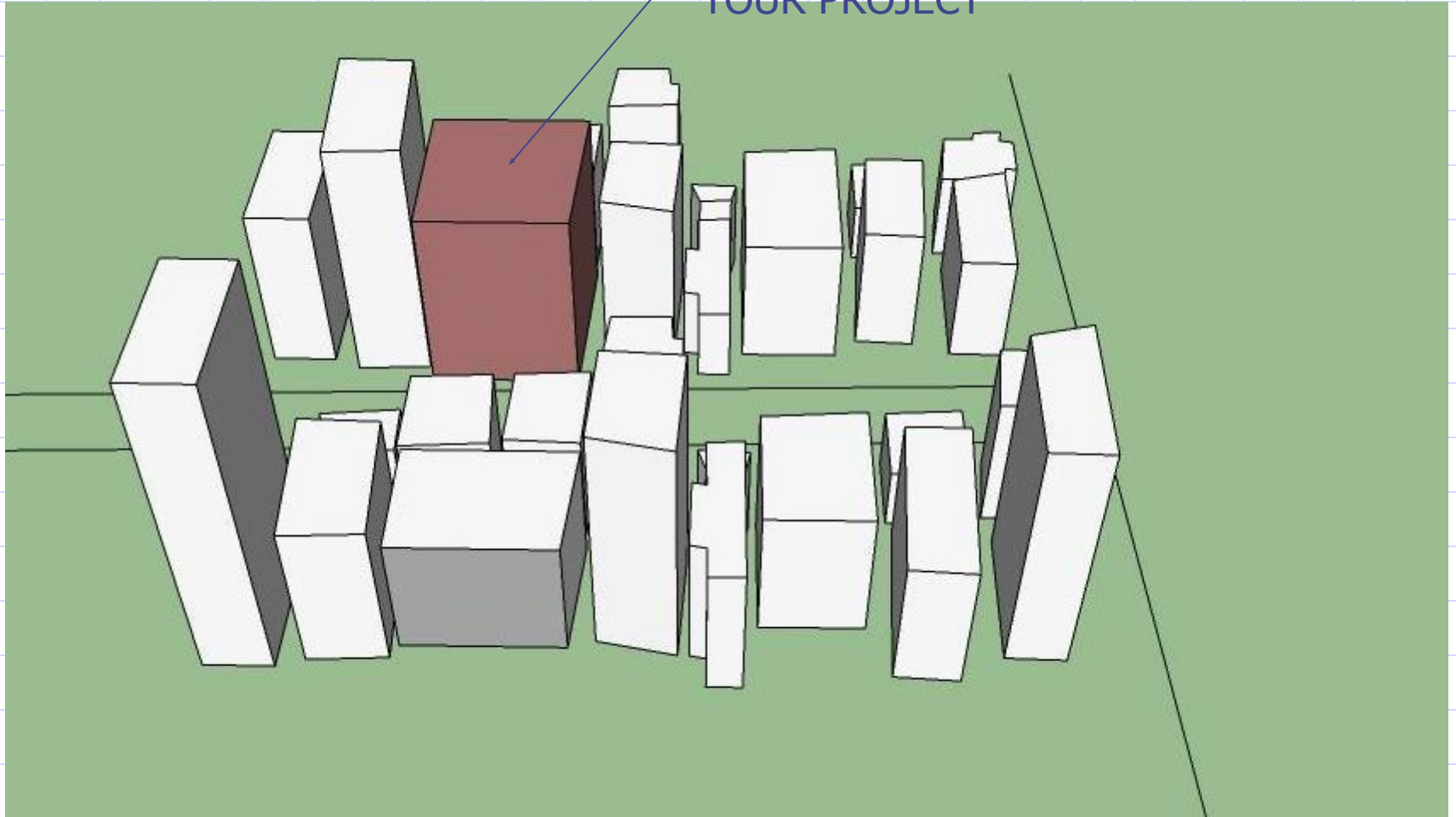
WIND LOAD

- THERE ARE MANY COMPUTATIONAL FLUID DYNAMICS (CFD) SOFTWARE AVAILABLE THAT CAN SIMULATE WIND TUNNEL TEST ON BUILDING.
- WHY NOT YOU TRY ONE FOR YOUR PROJECT?

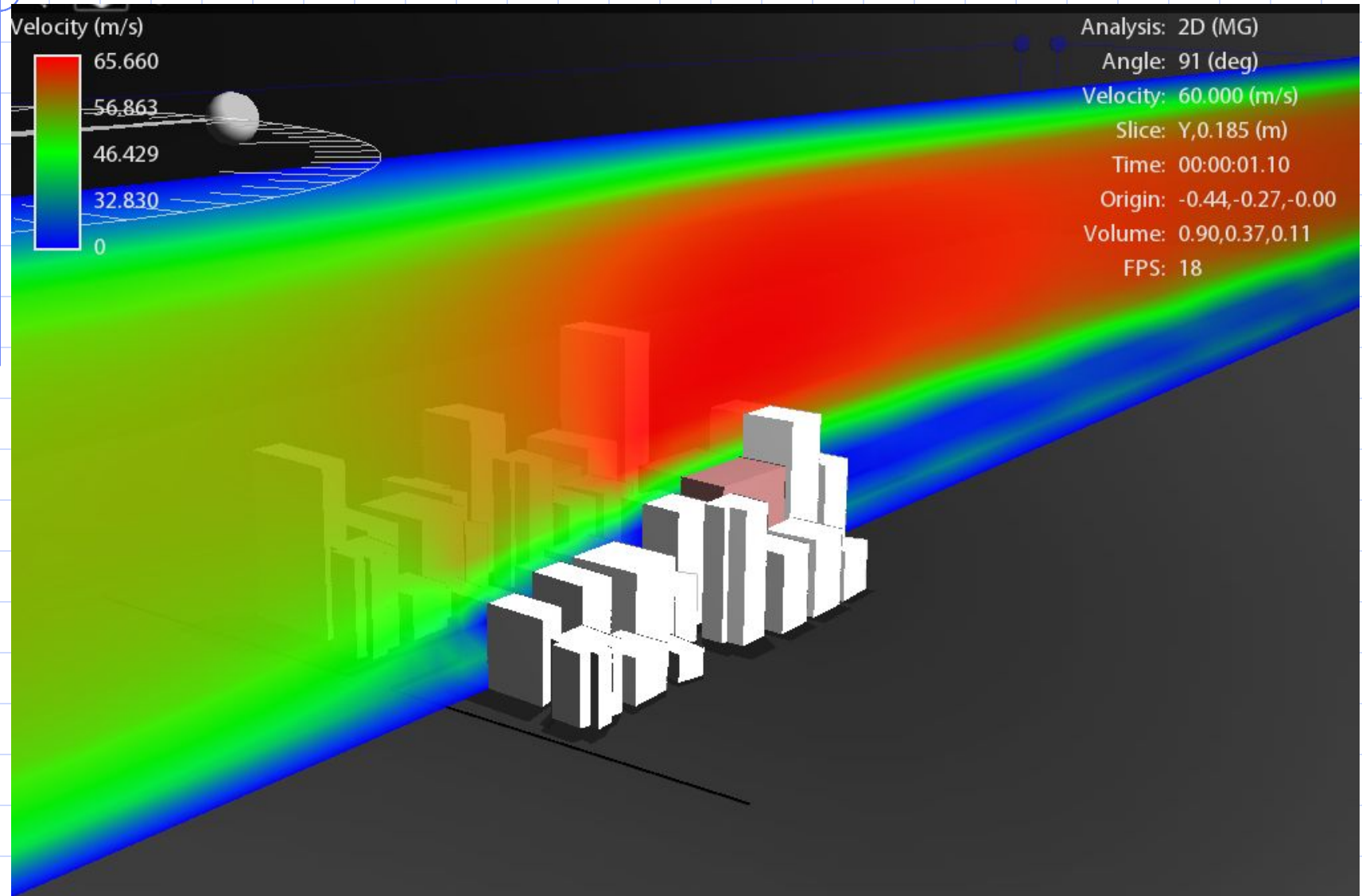
LETS SAY, AS A GAME.

WIND TUNNEL SIMULATION

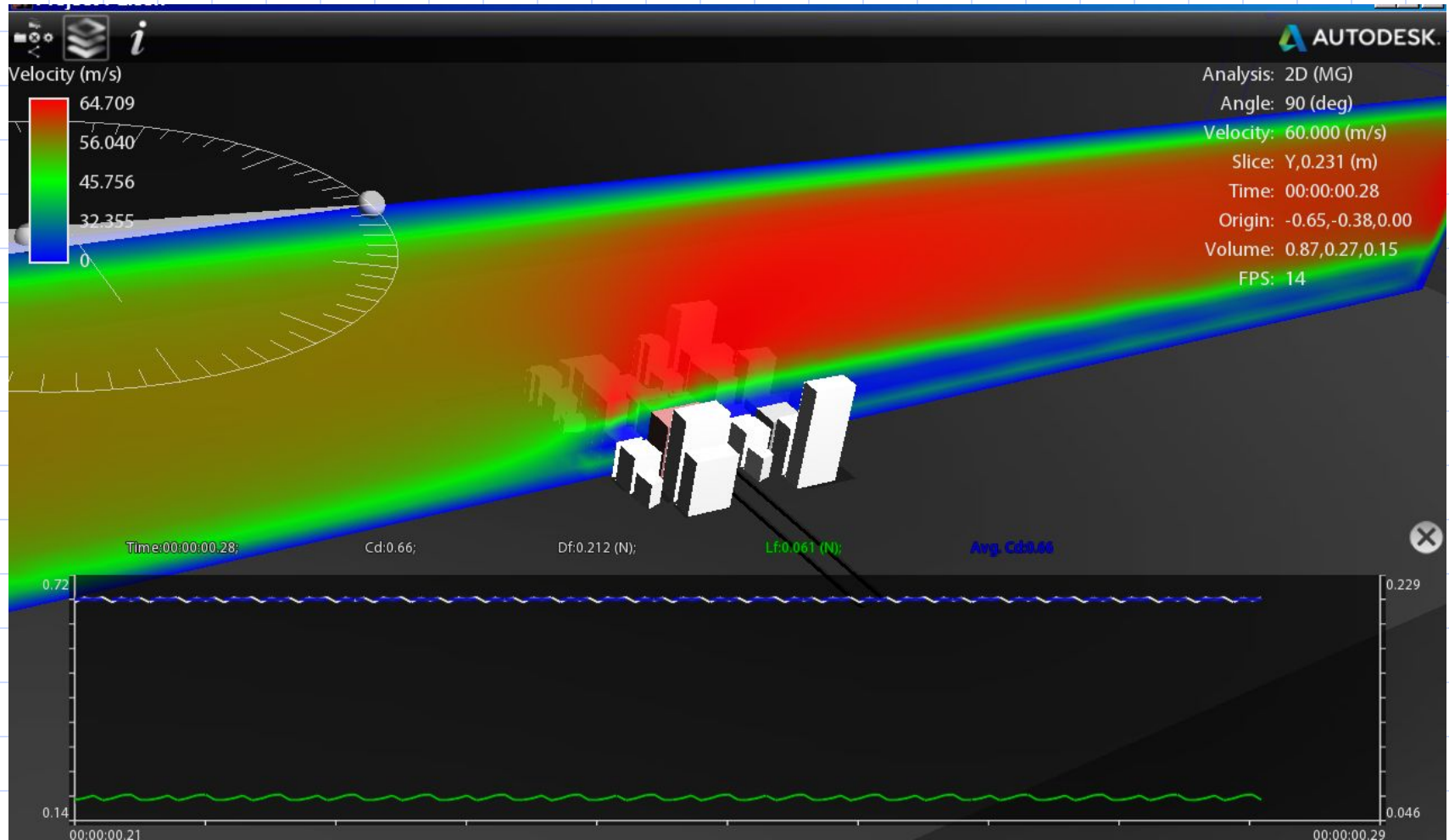
YOUR PROJECT



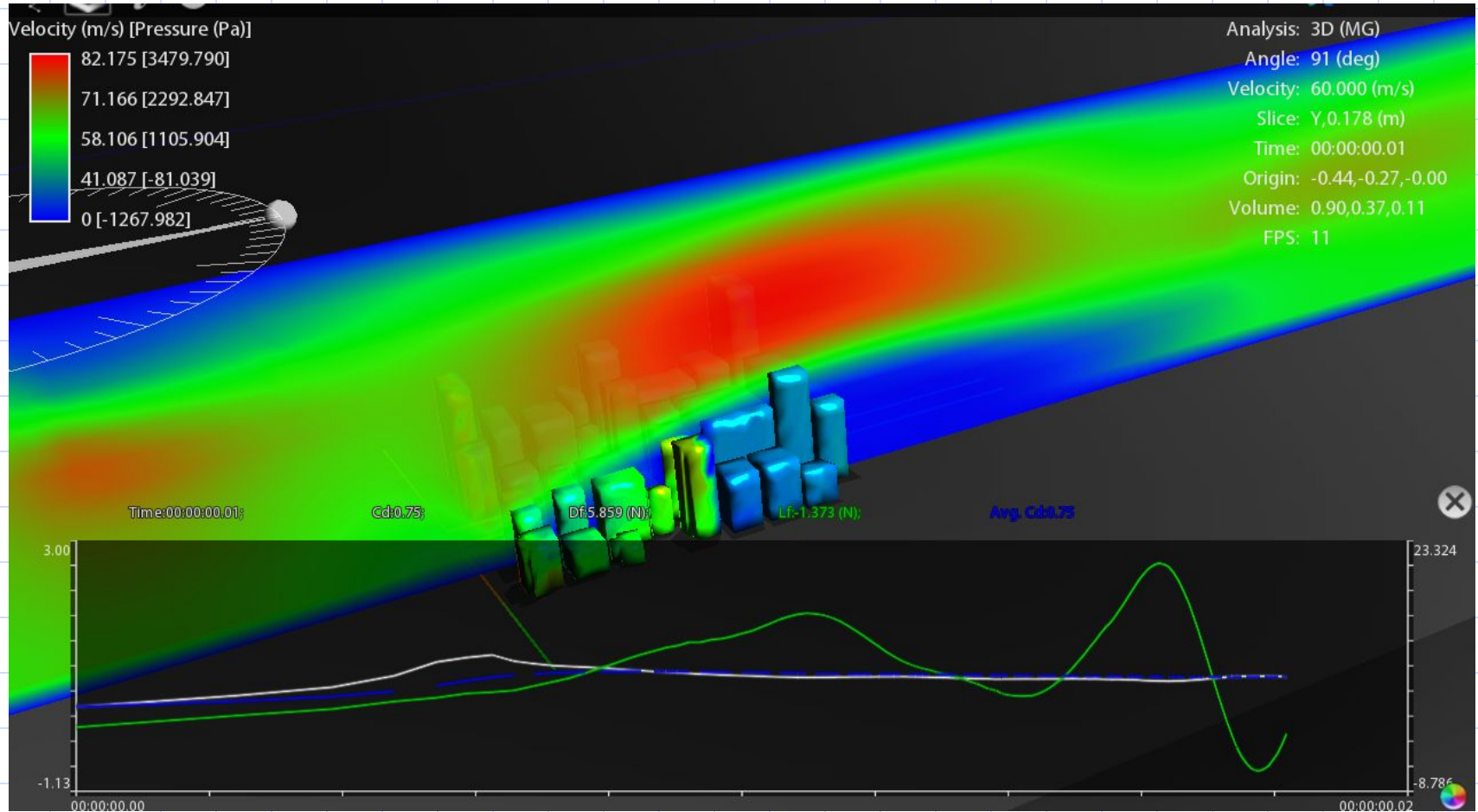
WIND TUNNEL SIMULATION



WIND TUNNEL SIMULATION



WIND TUNNEL SIMULATION



CRACK IN CONCRETE

- Concrete suppose to crack so that reinforcement can carry load.
- But limiting crack width is important for the durability of concrete.
- Limiting reinforcement stress at service level and spacing of reinforcement is an alternate way to reduce crack width and/or spacing.

CRACK SIMULATION

Alternately, we can simulate crack width and spacing using any FEA software.

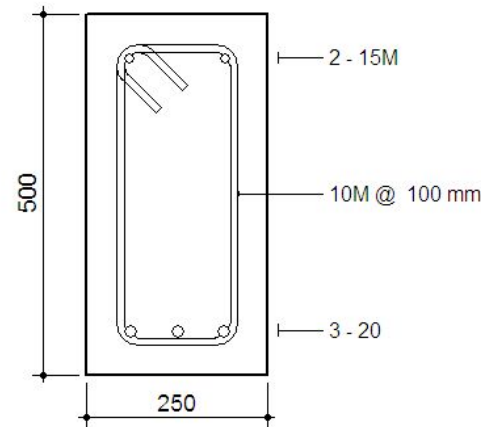
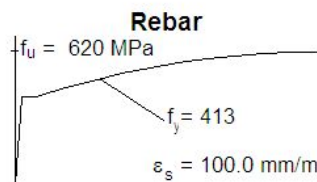
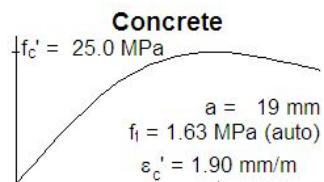
<u>Geometric Properties</u>		
	Gross Conc.	Trans (n=8.51)
Area (mm ²) x 10 ³	125.0	134.8
Inertia (mm ⁴) x 10 ⁶	2604.2	2949.2
y _t (mm)	250	255
y _b (mm)	250	245
S _t (mm ³) x 10 ³	10416.7	11553.4
S _b (mm ³) x 10 ³	10416.7	12050.7

Crack Spacing

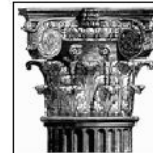
$$2 \times \text{dist} + 0.1 d_b / \rho$$

Loading (N,M,V + dN,dM,dV)

0.0 , 122.0 , 0.0 + 0.0 , 1.0 , 0.0



All dimensions in millimetres
 Clear cover to transverse reinforcement = 40 mm



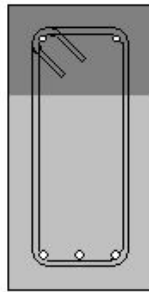
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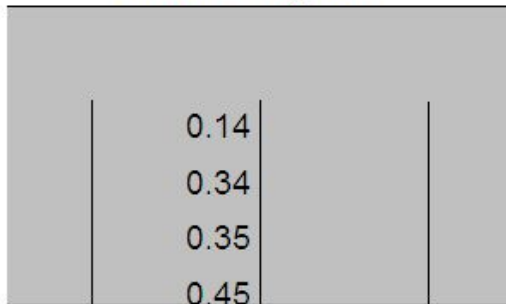
2013/6/17

CRACK SIMULATION

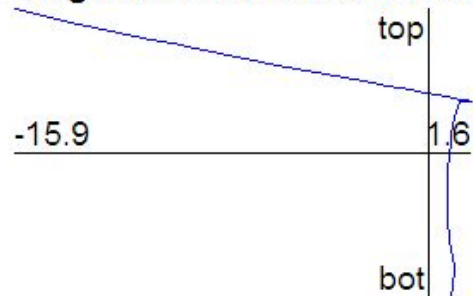
Cross Section



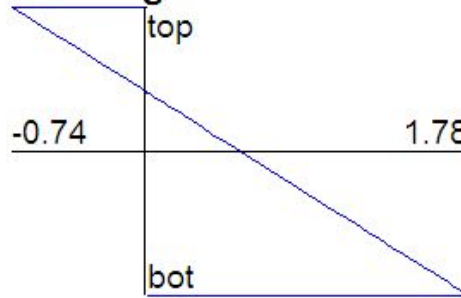
Crack Diagram



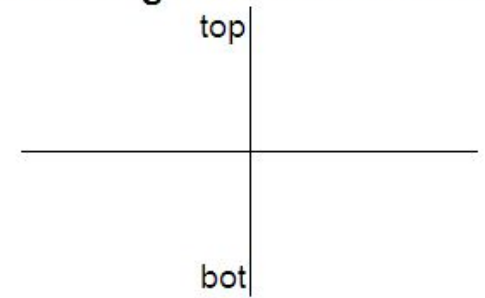
Longitudinal Concrete Stress



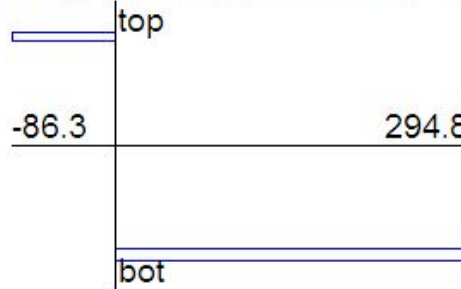
Longitudinal Strain



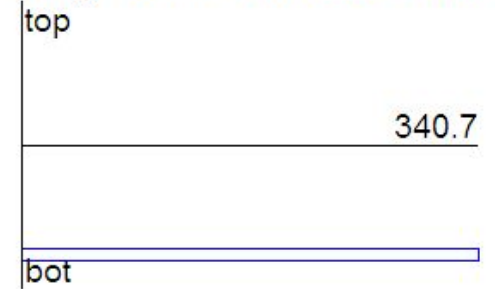
Shrinkage & Thermal Strain



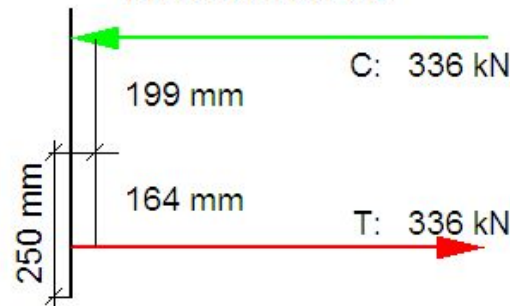
Long. Reinforcement Stress



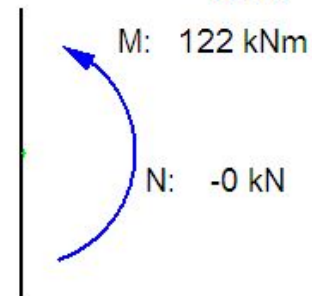
Long. Reinf Stress at Crack



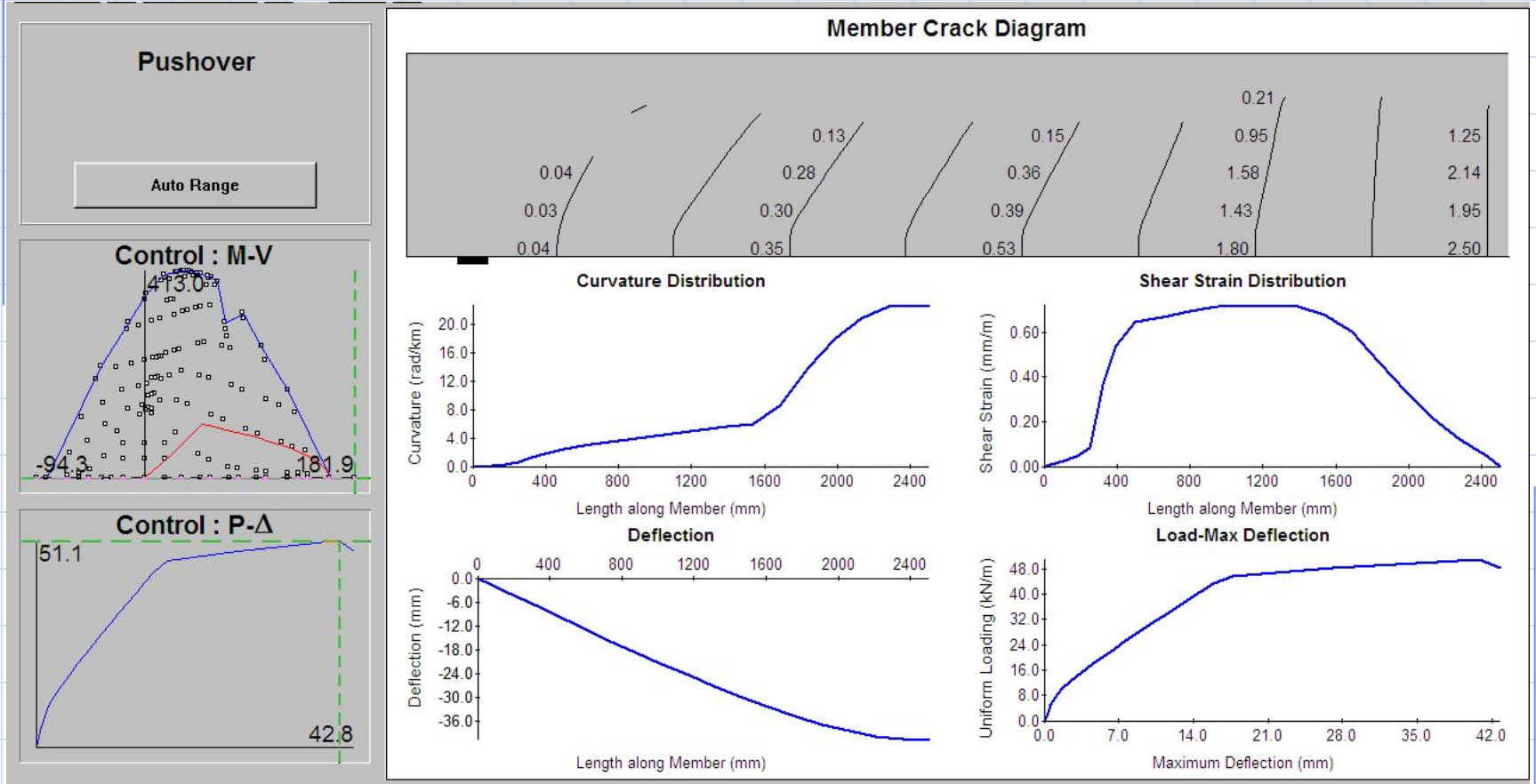
Internal Forces



N+M



CRACK SIMULATION



Good Construction Results in Safe Structure

LESSON 2

Three most important Issues for Good Concrete Construction

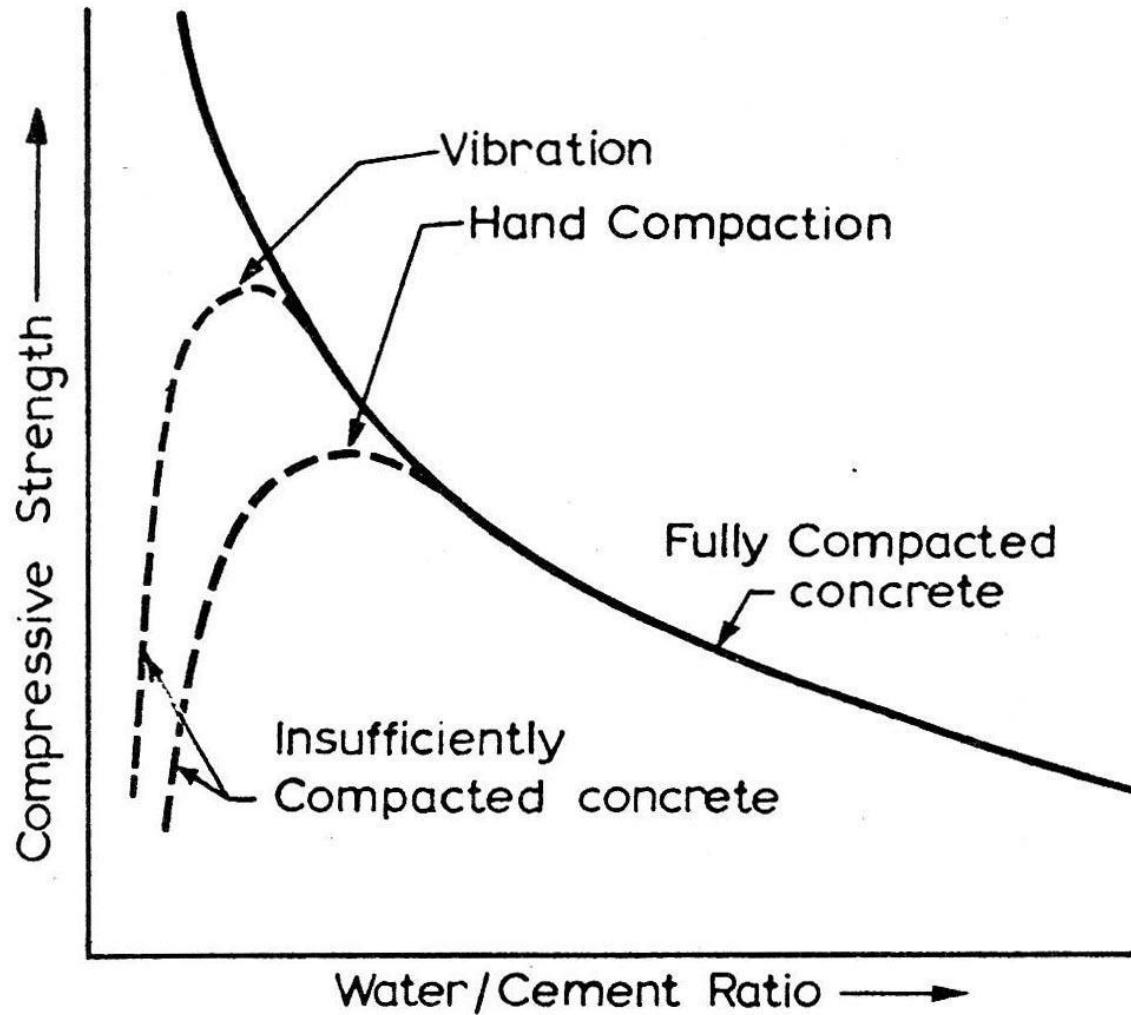
- Water-Cement Ratio
- Compaction
- Curing

Dry Concrete?

Never just add water to the concrete to make it more workable, always use a mix of cement paste (i.e. water AND cement).

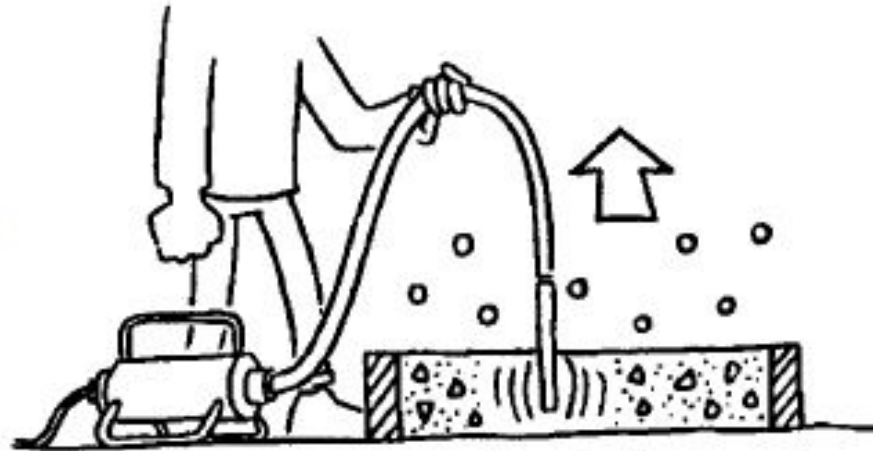


COMPRESSIVE STRENGTH OF CONCRETE



Water Cement Ratio VS Compressive Strength

Compaction of Concrete



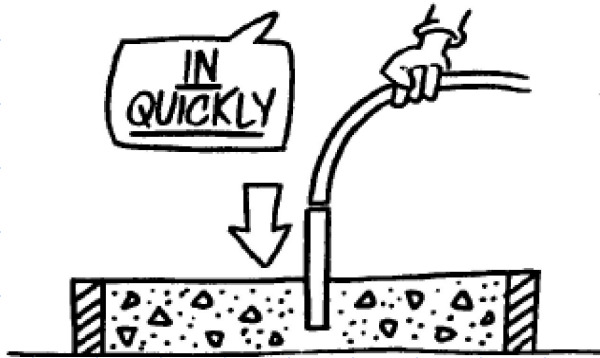
- As you shake & vibrate the concrete the AIR is pushed out.

Compaction is done by shaking, or vibrating, the concrete which liquefies it, allowing the trapped air to rise out.

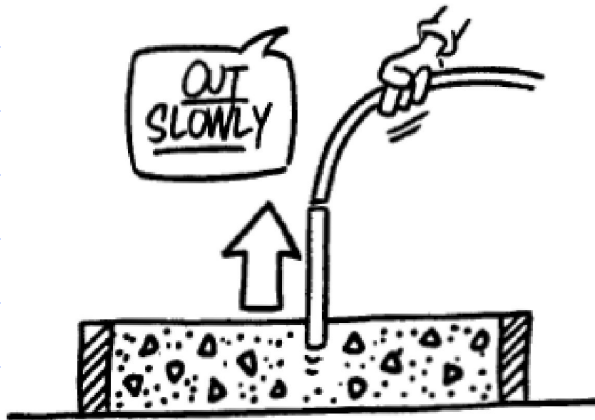
Compaction must be done as concrete is placed, while it is still plastic. Never let concrete dry-out and stiffen because it will be too hard to compact.

Properly compacted concrete is more dense, strong and durable. Off-form finishes will also be better.

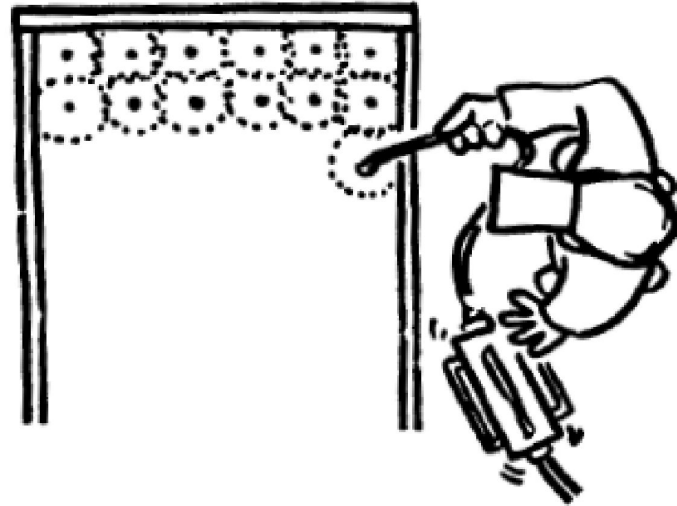
Compaction of Concrete



Put the poker into the concrete QUICKLY.



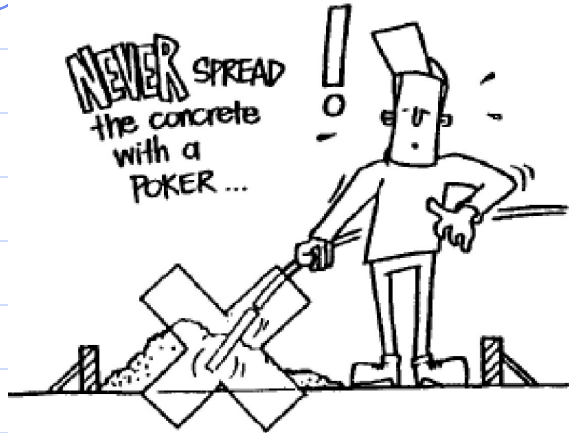
Take the poker out very SLOWLY



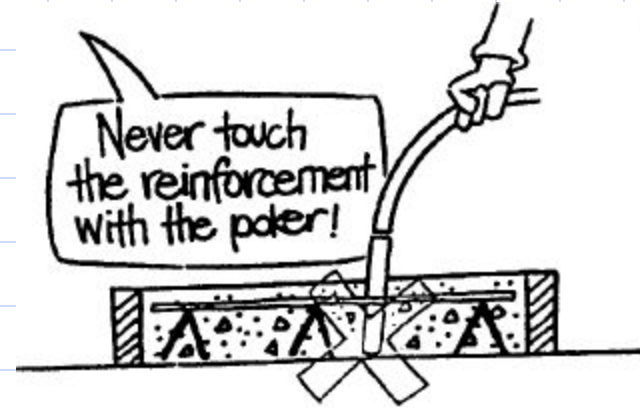
The area vibrated at one time is called the RADIUS OF ACTION. This can be seen by over what radius air bubbles rise to the surface. The radius of action will be greater with a LARGER poker and more-workable concrete.

Always compact in a definite pattern so the radius of action overlaps and covers the whole area of the concrete.

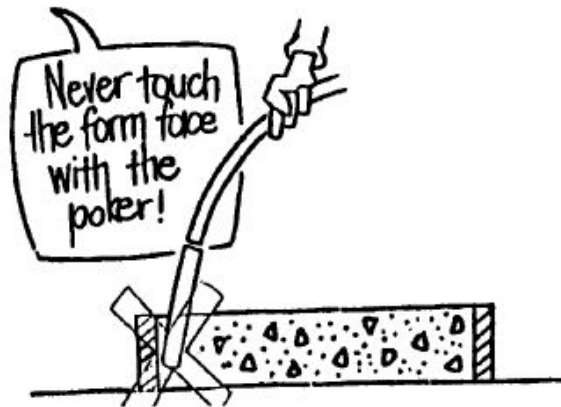
Compaction of Concrete



NEVER spread or move concrete sideways with the poker, always use a shovel.

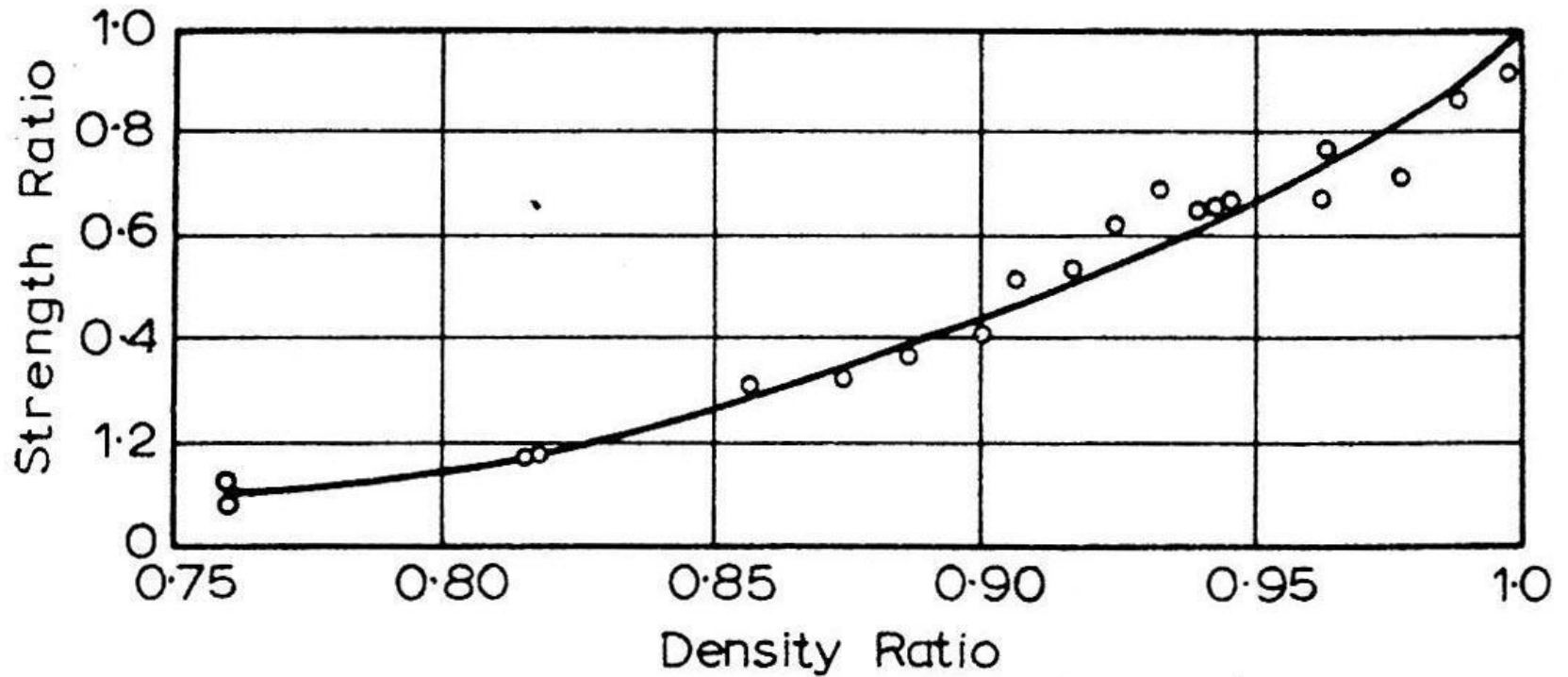


NEVER touch the reinforcement with the poker.



NEVER touch the form face with the poker as it can damage the formwork and the concrete.

COMPRESSIVE STRENGTH OF CONCRETE



Strength VS Compaction

Curing of Concrete



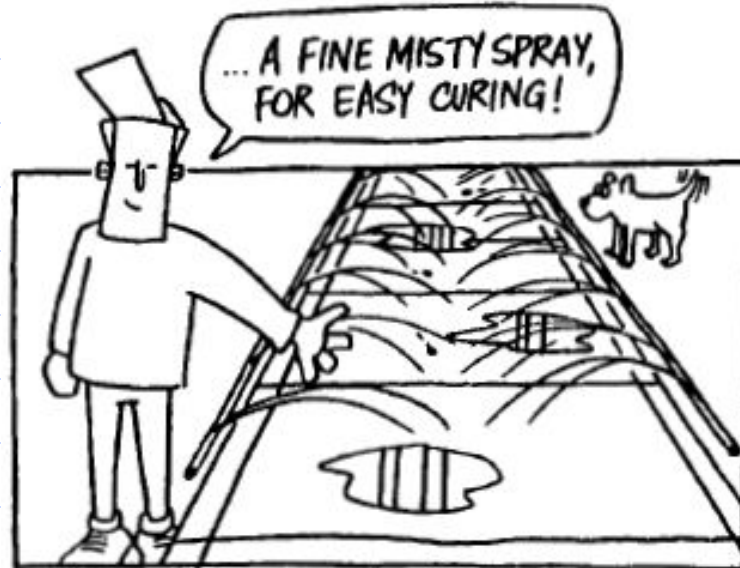
WHAT IS CURING ?

Curing means to cover the concrete so it stays MOIST. By keeping concrete moist the bond between the paste and the aggregates gets stronger. Concrete doesn't harden properly if it is left to dry out.

WHEN TO CURE?

Curing is done just after finishing the concrete surface, as soon as it will not be damaged.

Curing of Concrete



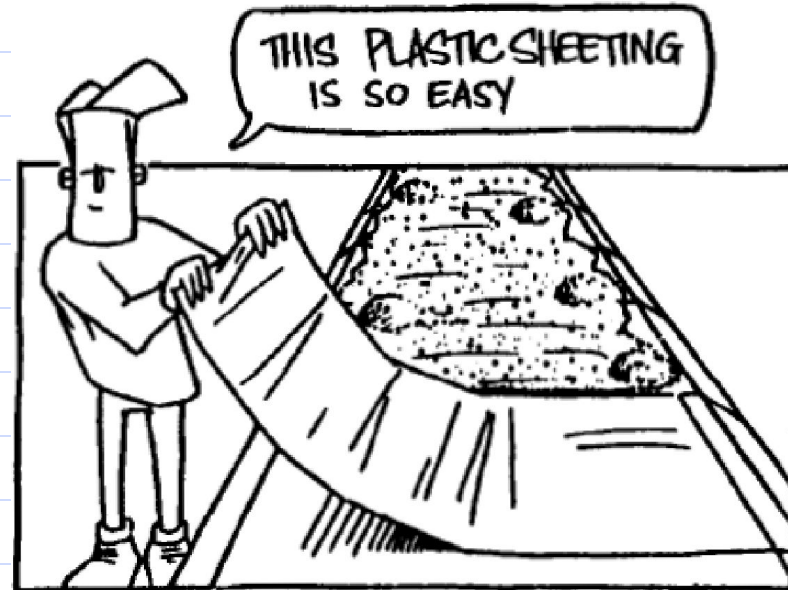
The simplest method of APPLYING WATER is to put a continuous fine, misty spray of water over the concrete.

BEWARE: The spray must be a very fine mist or else it will damage the surface of the concrete.

Concrete will dry out more quickly in hot weather. Keep the concrete continuously moist.

The most important thing in curing is to keep the concrete moist at all times. Hosing in the morning and again at night and letting the concrete dry out in between is no good.

Curing of Concrete



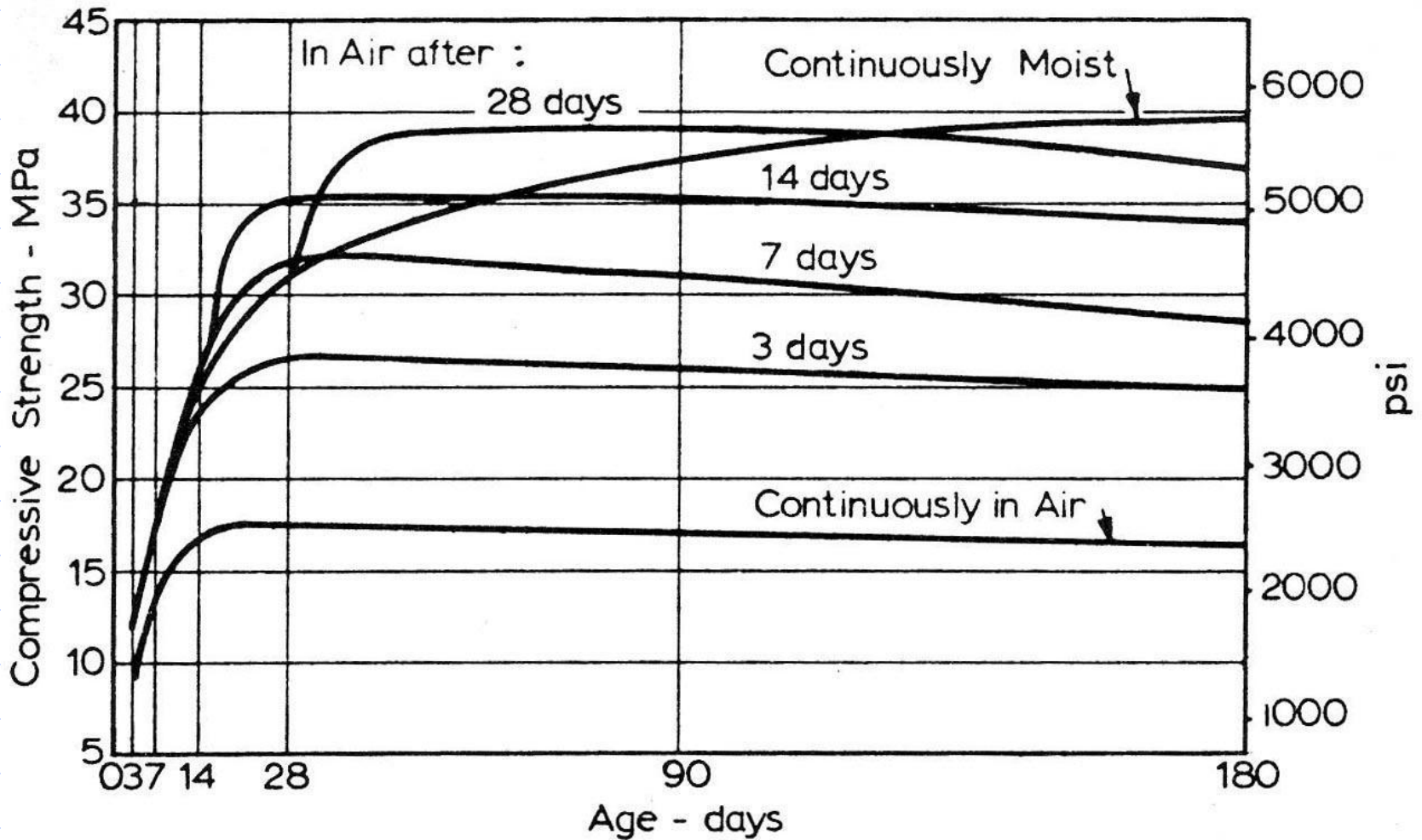
Another way to cure concrete is to cover with PLASTIC SHEETS to slow down water loss.

Concrete may also be cured by applying a CURING COMPOUND [EVAPORATIVE RETARDANT (Aliphatic Alcohol)] which slows water loss.

Recent example is 3rd Karnafuly Extradosed Cable Stayed Bridge.

Another passive way of Curing is to keep the formwork for long time.

COMPRESSIVE STRENGTH OF CONCRETE



Strength VS Curing

LAST BUT NOT THE LEAST

LESSON 3

NEVER EVER DO THESE

- Any design work without calculation.
- Left you drawing incomplete thinking that it would be done at site during construction.
- Provide a drawing without necessary information in it.

LESSON 4

NEVER EVER DO THESE

- Add cement grout on old concrete to pour new concrete. Fresh water is good enough. If required use jointing material e.g. SIKADUR-31 or other similar.
- Make a 'KICKER' for Column Casting. If you need something like a 'KICKER' to place the formwork – make it at least 300mm high so that you can vibrate it with Poker Vibrator. And NEVER use hand-mix concrete for such construction.



CIVIL ENGINEERING IS
NOT A WHITE COLLAR
JOB.

WITHOUT PROPOER
CONSTRUCTION
KNOWLEDGE & EXPERIENCE
YOU WILL NEVER BE GOOD
DESIGNEER.



FURTHER QUESTIONS?

Feel free to knock me at:

www.sabbirsiddique.com