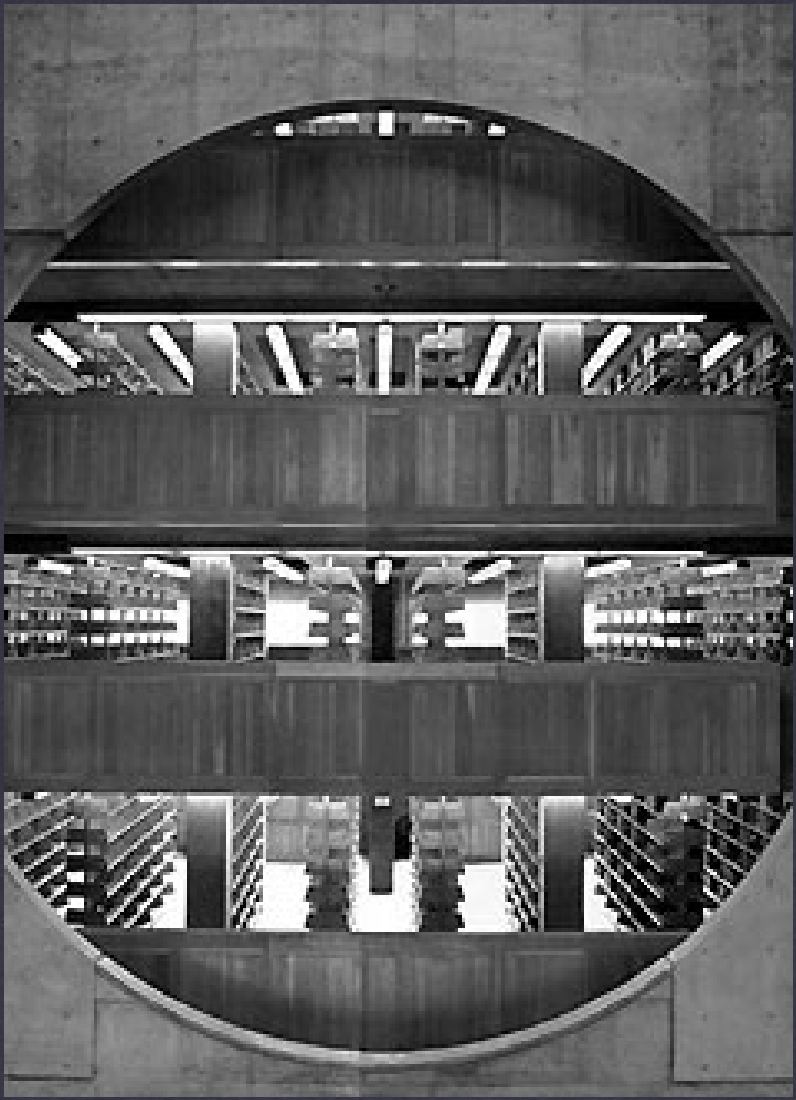
ARCH 1230

BUILDING TECHNOLOGY II

Professor Friedman

Fall 2012




SUBJECT

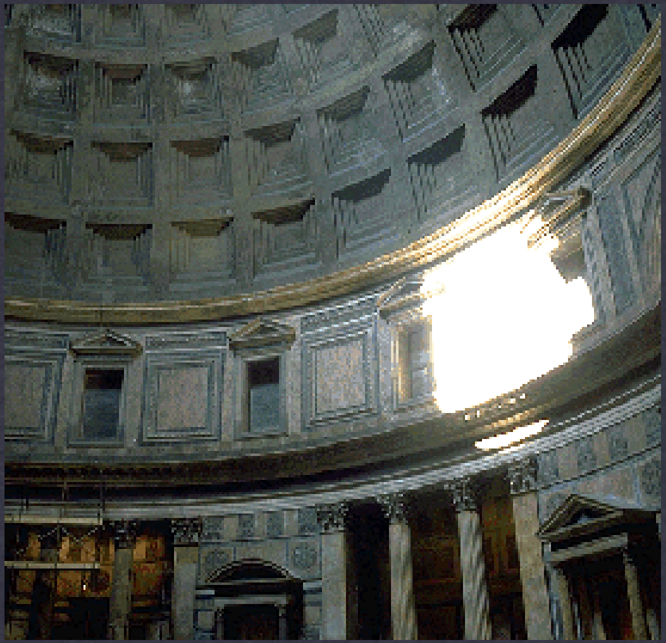
Concrete

material and use in construction

chapter 13

DATE Fall 2012

PROFESSOR Friedman


Concrete

Professor Friedman

Arch 1230

CONCRETE

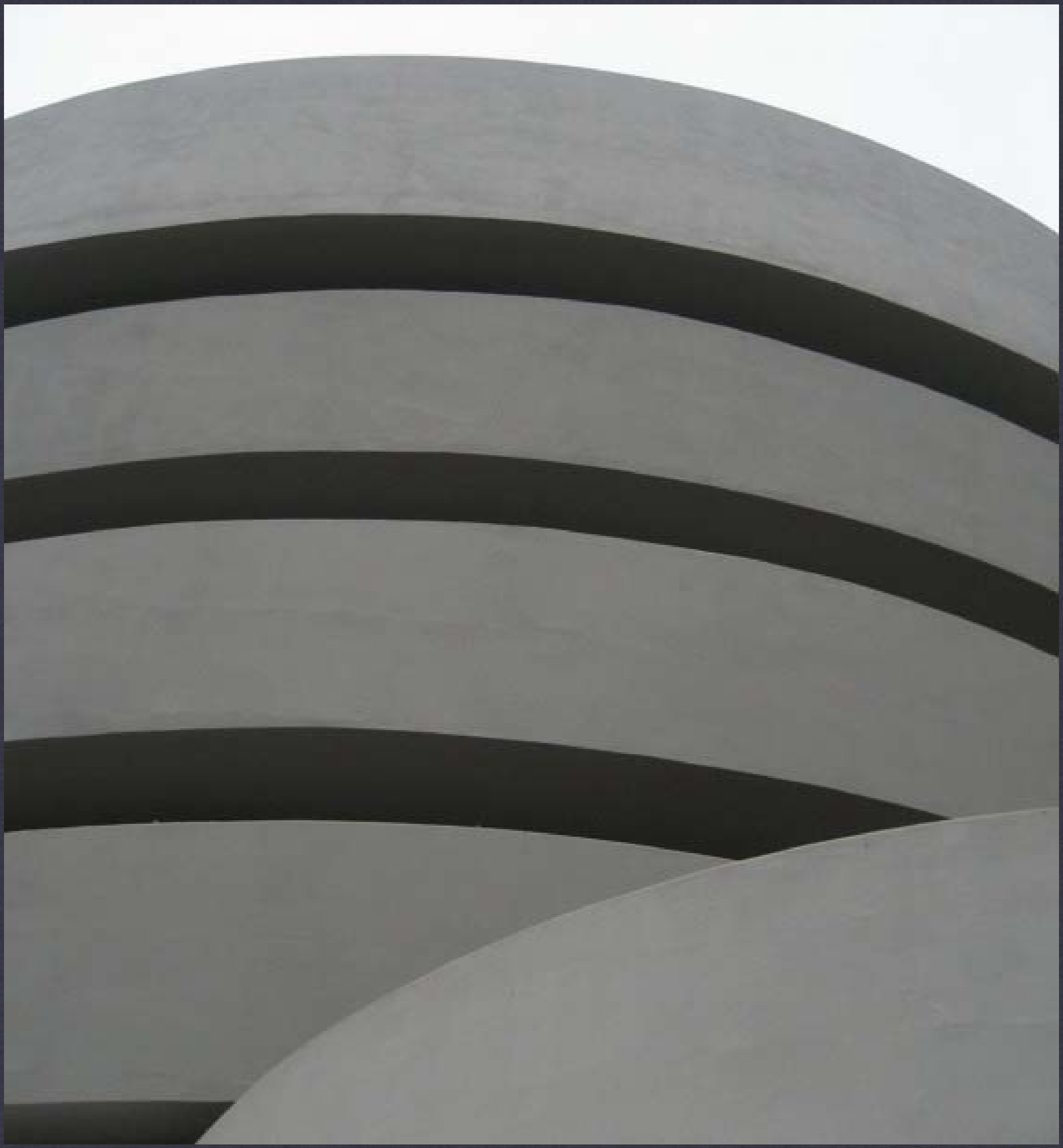
Professor Friedman

Arch 1230

CONCRETE

Professor Friedman

Arch 1230



CONCRETE

Professor Friedman

Arch 1230



CONCRETE

Professor Friedman

Arch 1230



CONCRETE

Professor Friedman

Arch 1230

this week

objective:
overview of the nature and composition of concrete and its broad application in construction

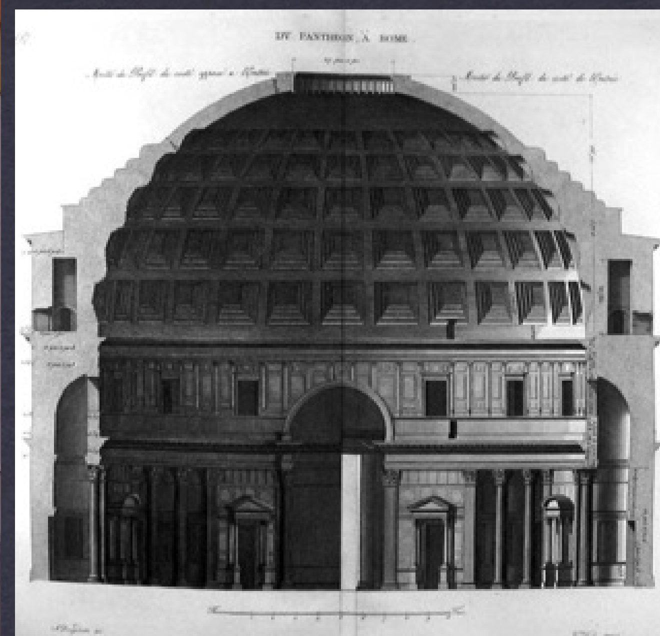
- roman discovery and development
- cement and concrete
- making and placing concrete
- formwork
- reinforcing
- concrete creep
- prestressing

The Romans discovered a silica and alumina bearing material on the slopes of Mount Vesuvius that when mixed with limestone and burned, produced a cement that exhibited a unique property: When mixed with water and sand, it produced a mortar that could harden both underwater and in the air.

The new cement was harder, stronger, more adhesive and cured quicker than ordinary mortar.

CONCRETE

pozzolana cement (volcanic rock)



CONCRETE

pozzolana cement (volcanic rock)

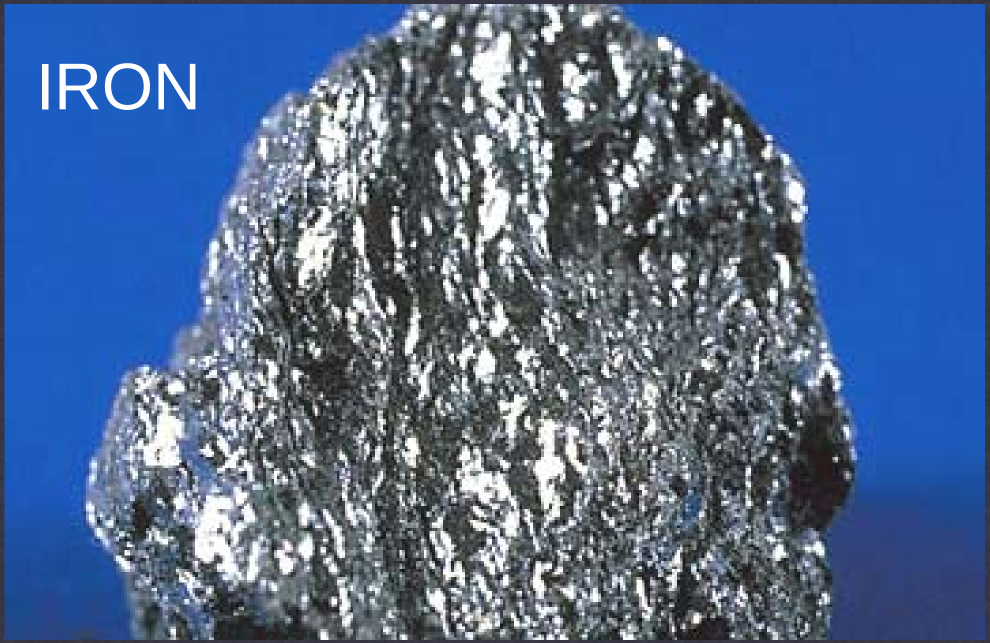
Professor Friedman

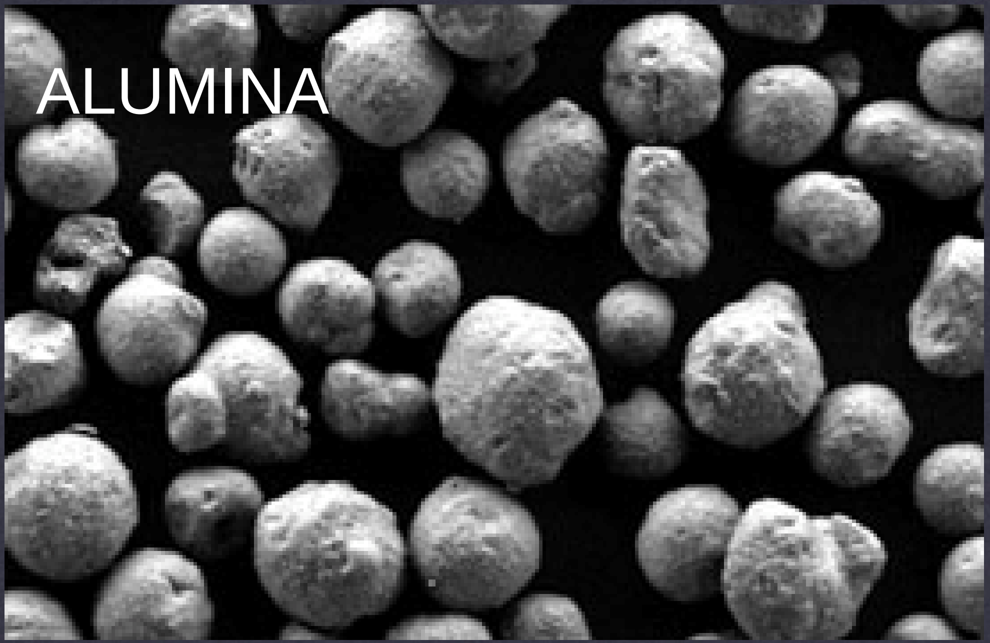
Arch 1230

Patented an artificial cement he named Portland cement after English Portland limestone.

CONCRETE

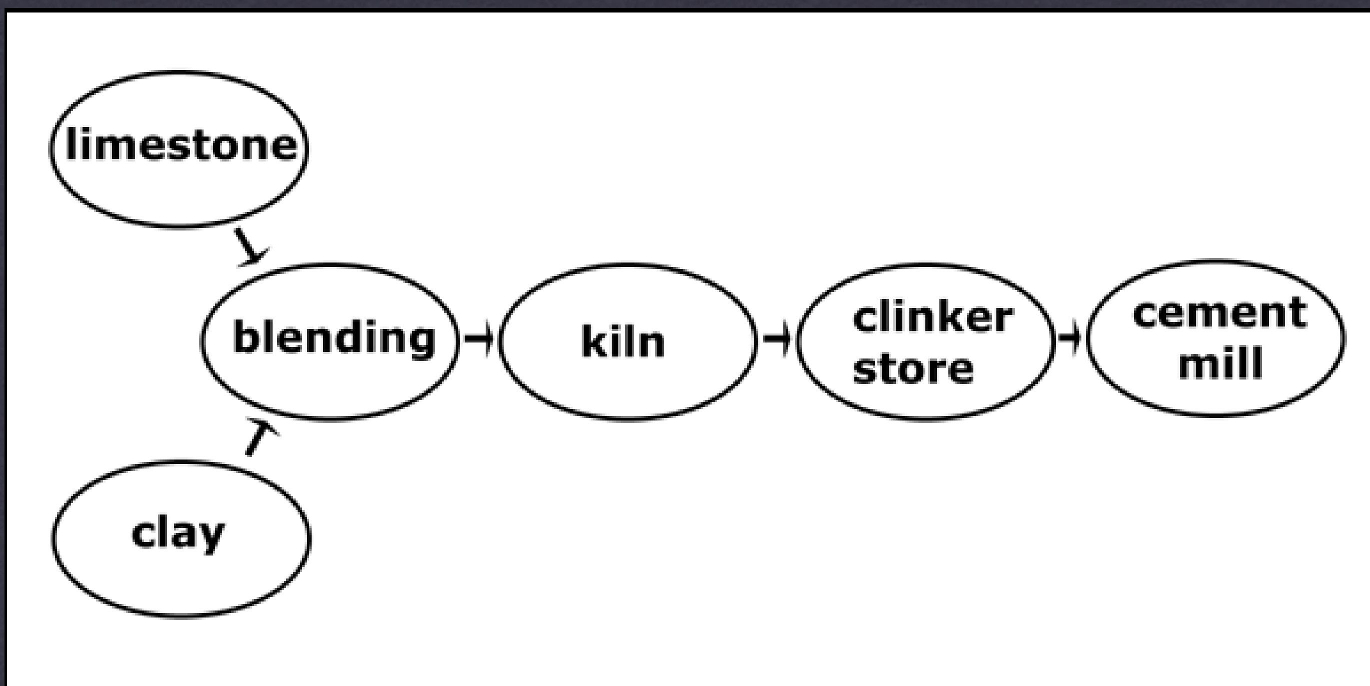
portland cement: 1824 Joseph Aspdin





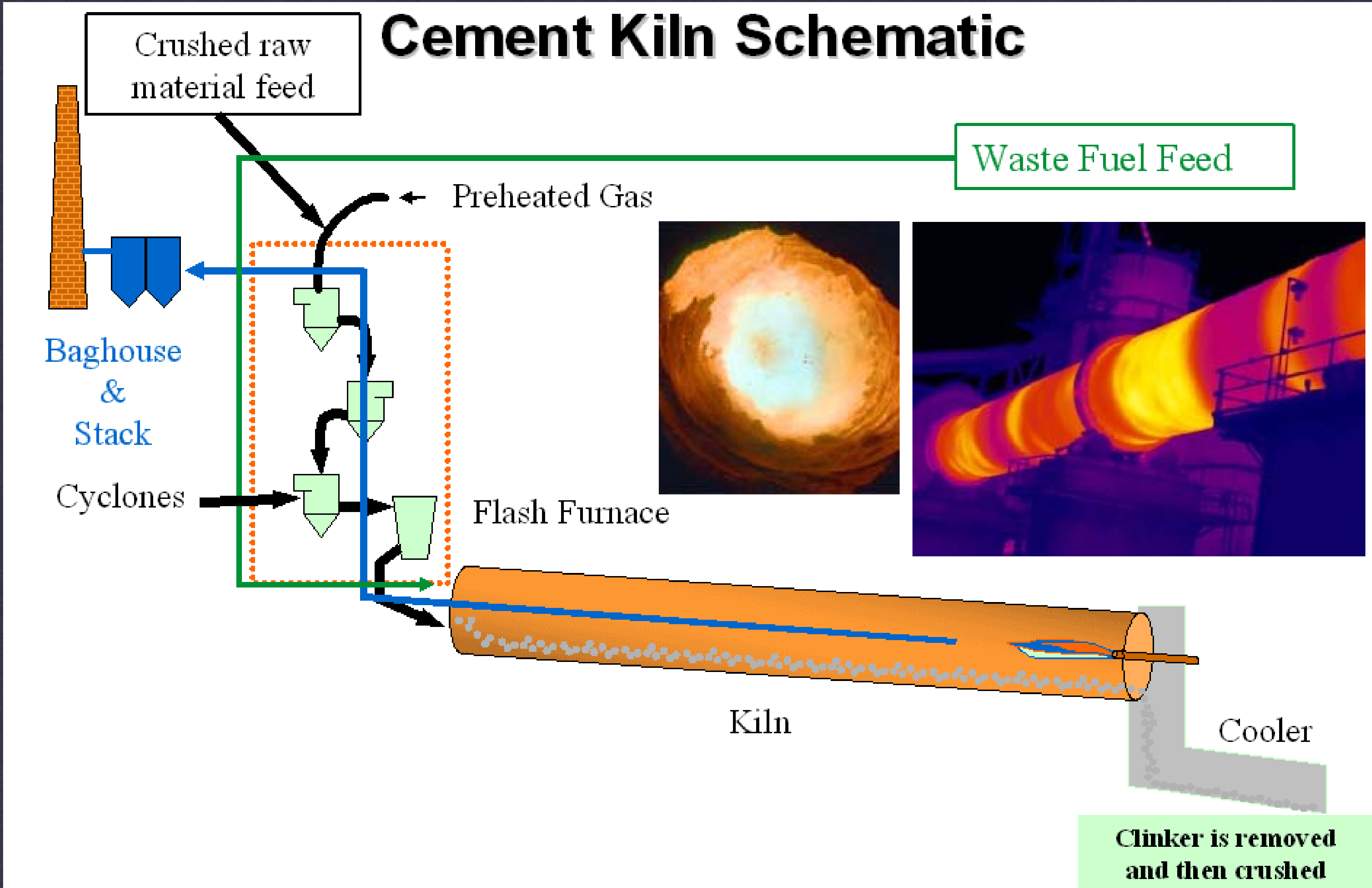
PORTLAND CEMENT

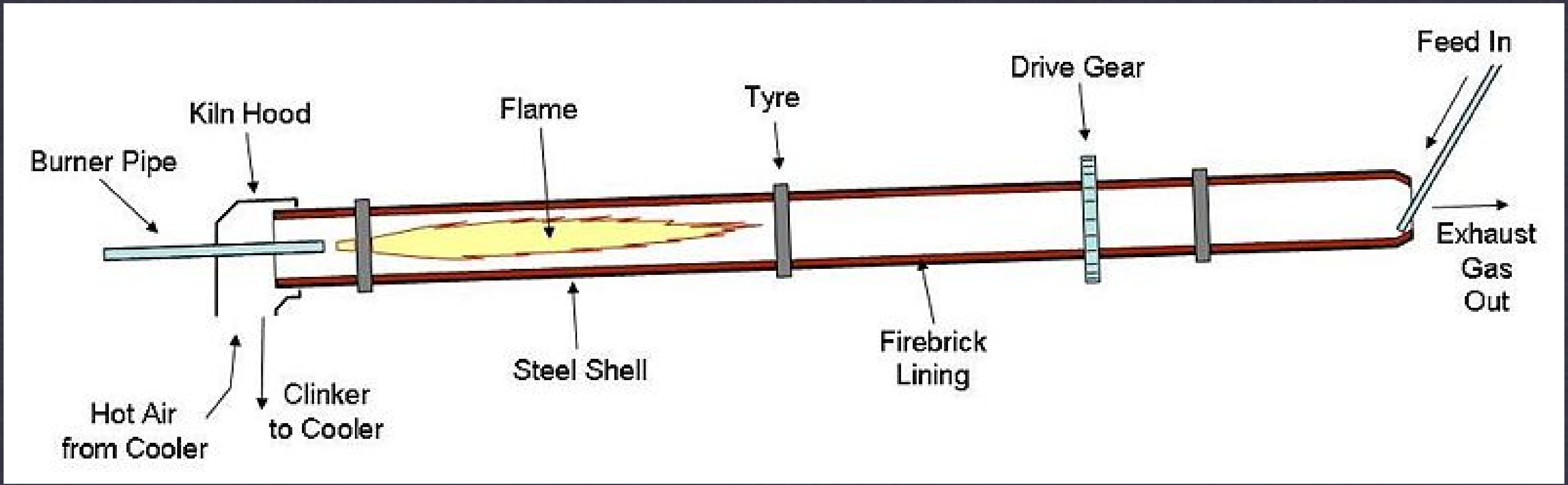
elements



PORTLAND CEMENT

portland cement manufacturing


Cement Kiln Schematic
Crushed raw material feed
Waste Fuel Feed
Preheated Gas
Baghouse & Stack
Cyclones
Flash Furnace
Kiln
Cooler
Clinker is removed and then crushed



PORTLAND CEMENT

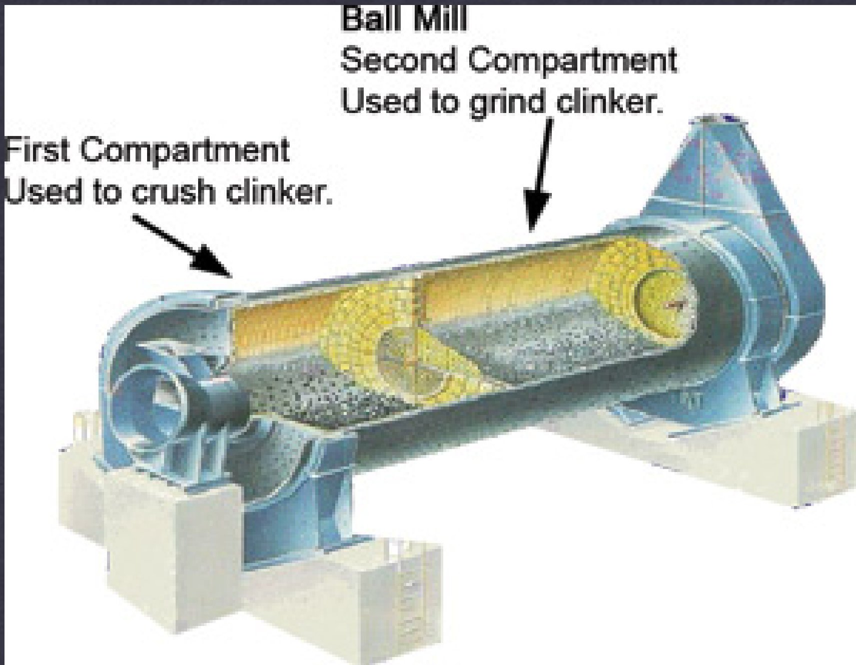
portland cement manufacturing- kilns

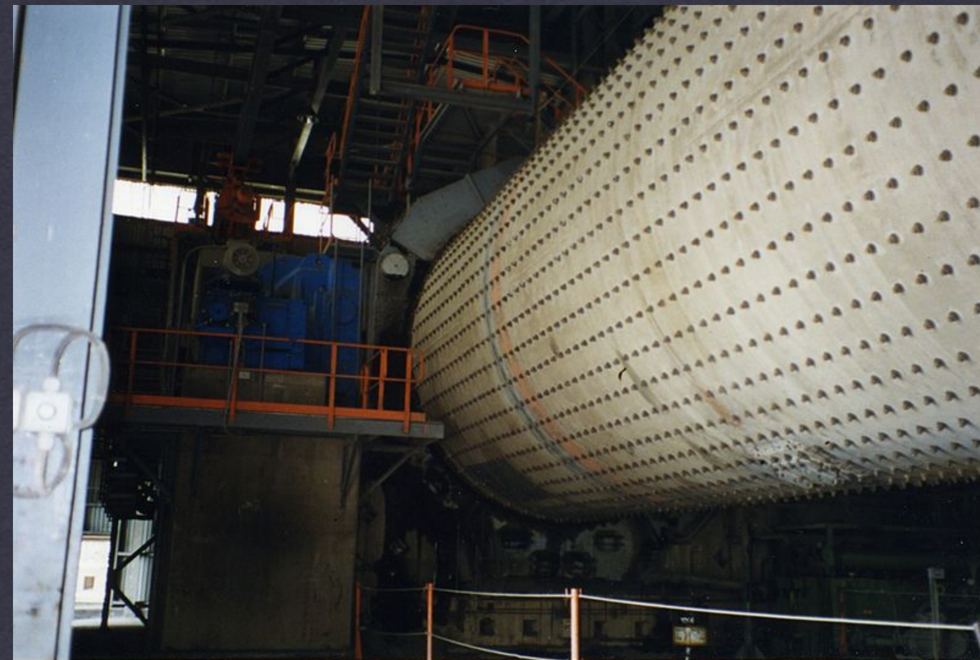
PORTLAND CEMENT

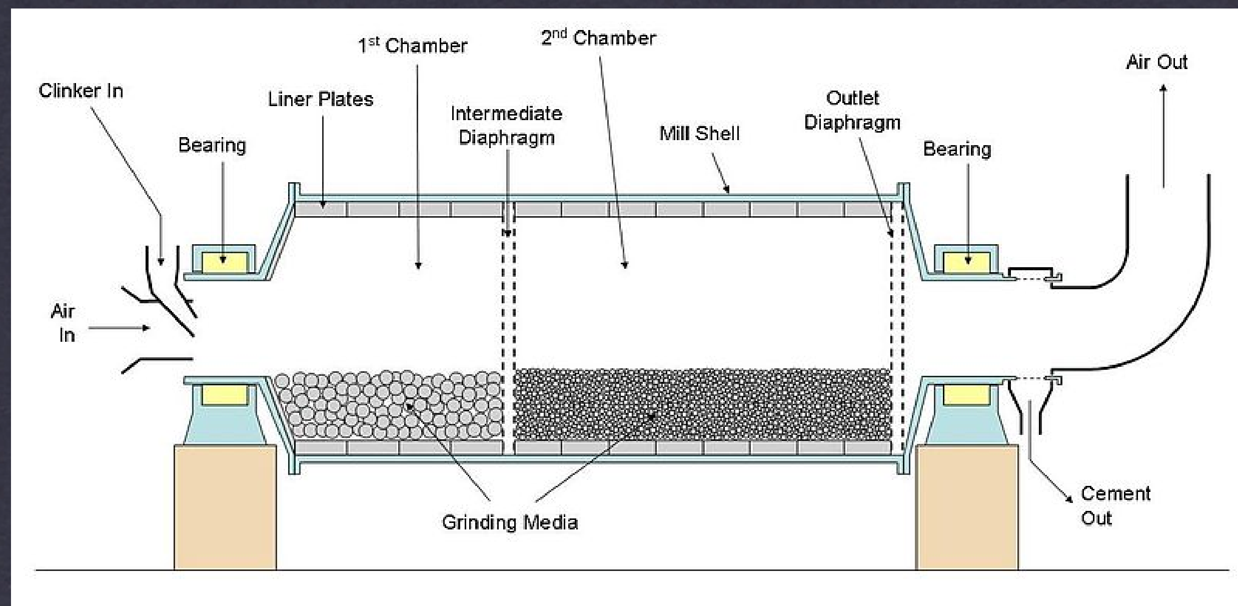
portland cement manufacturing- clinker

Professor Friedman

Arch 1230







PORTLAND CEMENT

Professor Friedman

Clinker ground into Cement

Arch 1230

PORTLAND CEMENT

product shipment

Quality of Portland cement established by ASTM C150, identifies 8 types:

-Type I: Normal

-Type IA: Normal, air entraining

-Type II: Moderate resistance to sulfate attack

-Type IIA: Moderate sulfate resistance, air entraining

-Type III: High early strength

-Type IIIA: High early strength, air entraining

-Type IV: Low heat of hydration

-Type V: High resistance to sulfate attack.

Quality of Portland cement established by ASTM C150, identifies 8 types:

-Type I: Normal

-Type IA: Normal, air entraining

-Type II: Moderate resistance to sulfate attack

-Type IIA: Moderate sulfate resistance, air entraining

-Type III: High early strength

-Type IIIA: High early strength, air entraining

-Type IV: Low heat of hydration

-Type V: High resistance to sulfate attack.

-Type I cement used for most purposes…
-Type II and V used when the concrete will be in direct contact with water that has high amounts of sulfate.
-Type III hardens quickly (used in cold climates where the concrete has to dry quickly)…

-Type IV used in large structures (dams) where heat emitted during curing can raise the temperature to damaging levels (due to thickness of concrete.

PORTLAND CEMENT

Professor Friedman

Cement Types

Arch 1230

Air Entrained Cement

-Type IA: Normal, air entraining

-Type IIA: Moderate sulfate resistance, air entraining

-Type IIIA: High early strength, air entraining

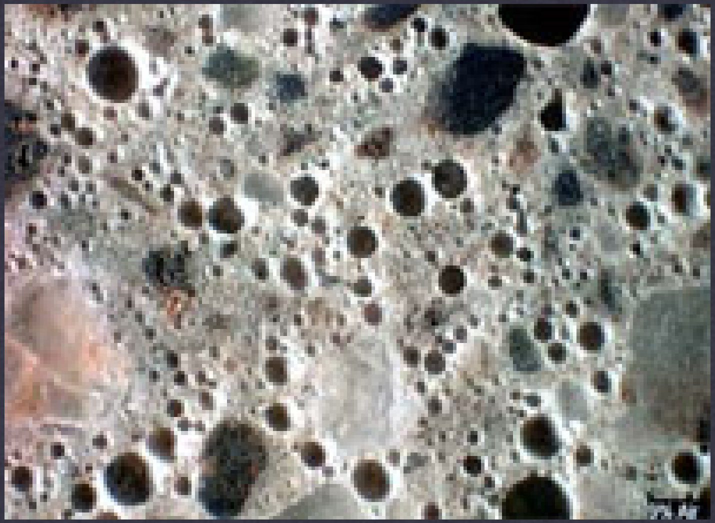
Contain ingredients that cause microscopic air bubbles to form in the concrete during mixing.

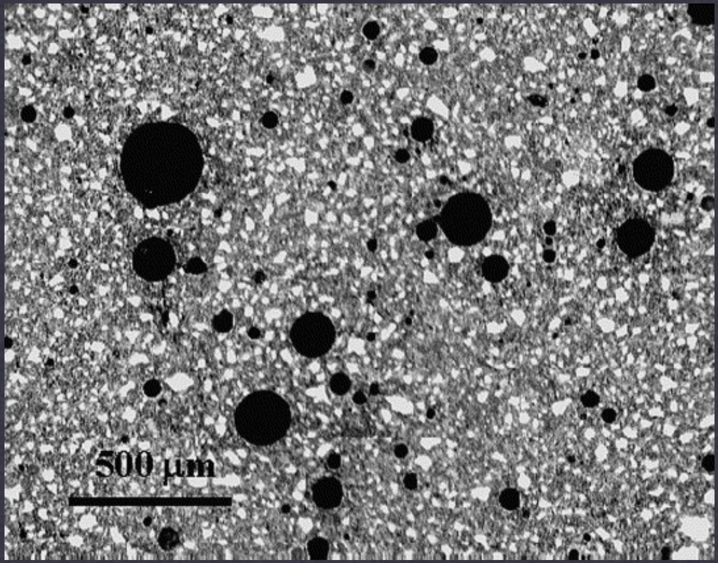
The bubbles comprise 2- 8 % of the finished concrete volume.

-Improves workability during placement

-Greatly increases the resistance of concrete to damage by repeated cycles of freezing and thawing.

-Commonly used in pavings and exposed concrete in cold climates.



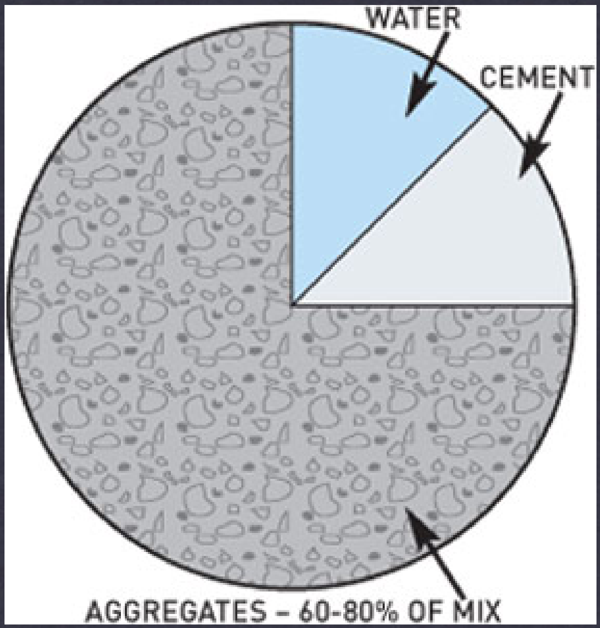


CONCRETE

elements

Professor Friedman

Arch 1230



Aggregates make up roughly ¾ of the volume of concrete, so the structural strength is heavily dependent on the quality of it's aggregates.

-Size distribution is important. A range of sizes must be used to achieve close packing of the particles.

-The Largest particle must be small enough to pass easily between the most closely spaced rebars.

-In general, the maximum aggregate size should not be greater than ¾ of the clear spacing between bars or 1/3 the depth of the slab.

-For very thin slabs and toppings, a 3/8 inch max aggregate diameter is specified.

-A ¾" or 1-1/2" max size is most common.

-In large scale projects, like Dams, aggregate up to 6" can be used to save money (need less concrete).

Aggregates

Supplementary materials may be added to mixtures as a substitute for some portion of the cement…

-*Fly ash*- fine powder that increases strength, decreases permeability, increases sulfate resistance, reduces temperature rise during curing, improves workability of mix.

-*Silica fume*- produces extremely high-strength concrete with low permeability.

-*Natural pozzolans*- reduces the internal temperatute when curing and improves workability.

-*High reactivity metakaolin*- enhances brilliance of color. (used in exposed architectural concrete conditions).

-Blast furnice slag- improves workability, increases strength, reduces permeability and temperature rise.

PORTLAND CEMENT

Supplementary Cementitious Materials

Professor Friedman

Arch 1230

Ingredients other than cement, water, aggregate, and supplementary materials…
These are added to alter the properties in various ways…

-Air-entraining admixtures- increase workability of wet concrete.

-Water-reducing admixtures- allow reduction in mixing water needed, resulting in higher strength concrete.

-Superplasticizers- improves flow properties of concrete allowing it to freely flow through formwork.

-Accelerating admixtures- allows concrete to cure rapidly.
-Retarding admixtures- slow curing to allow more working time.

-Shrinkage-reducing admixtures- reduce shrinkage/ cracking.

-Corrosion inhibitors- reduce rusting of rebar.

-Freeze protection- prevents freezing at low temperatures.

-Coloring agents.

CONCRETE

quality is related to end use

Professor Friedman

Arch 1230

Mixing concrete on site

CONCRETE

Professor Friedman

Arch 1230

CONCRETE

Mixing concrete OFF site

Professor Friedman

Arch 1230

Transporting mixed concrete to site

CONCRETE

Professor Friedman

Arch 1230

RULES FOR HIGH QUALITY CONCRETE WORK:

1. USE CLEAN, SOUND INGREDIENTS

2. MIX THEM IN THE CORRECT PROPORTIONS

3. HANDLE THE WET CONCRETE PROPERLY TO AVOID SEGREGATING ITS INGREDIENTS

4. CURE THE CONCRETE CAREFULLY UNDER CONTROLLED CONDITIONS

DETERMINING CONCRETE MIXTURES:

1. ESTABLISH THE DESIRED WORKABILITY CHARACTERISTICS OF THE WET CONCRETE

2. DETERMINE THE DESIRED PHYSICAL PROPERTIES OF THE CURED CONCRETE

3. DEFINE THE ACCEPTABLE COST OF THE CONCRETE WITH A FOCUS ON NOT UNNECESSARILY EXCEEDING REQUIRED QUALITY

QuickTime™ and a
decompressor
are needed to see this picture.

POURING CONCRETE

importance of procedure

Professor Friedman

Arch 1230

COMPRESSIVE STRENGTH:
2000 PSI

COMPRESSIVE STRENGTH:
20,000 PSI

CONCRETE

range of compressive strengths

Professor Friedman

Arch 1230

DEPENDENT ON AMOUNT OF CEMENT AND ON THE WATER-CEMENT RATIO

TYPICAL WATER-CEMENT RATIO: 45-60%

MORE WATER: INCREASE WORKABILITY BUT REDUCE STRENGTH

CONCRETE

Professor Friedman

strength of concrete

Arch 1230

CONCRETE

mixing truck - pump truck - form work

Professor Friedman

Arch 1230

CONCRETE

Concrete Boom- pouring

Professor Friedman

Arch 1230

CONCRETE

placing concrete: avoid segregation

Professor Friedman

Arch 1230





CONCRETE

placing concrete: Drop chutes

Professor Friedman

Arch 1230

CONCRETE

Professor Friedman

Leveling concrete

Arch 1230

CONCRETE

Professor Friedman

Leveling concrete

Arch 1230

CONCRETE

Professor Friedman

testing site concrete: slump test

Arch 1230

testing site concrete: cylinder test

CONCRETE

Professor Friedman

Arch 1230

CONCRETE

Professor Friedman

formwork

Arch 1230

CONCRETE

formwork

Professor Friedman

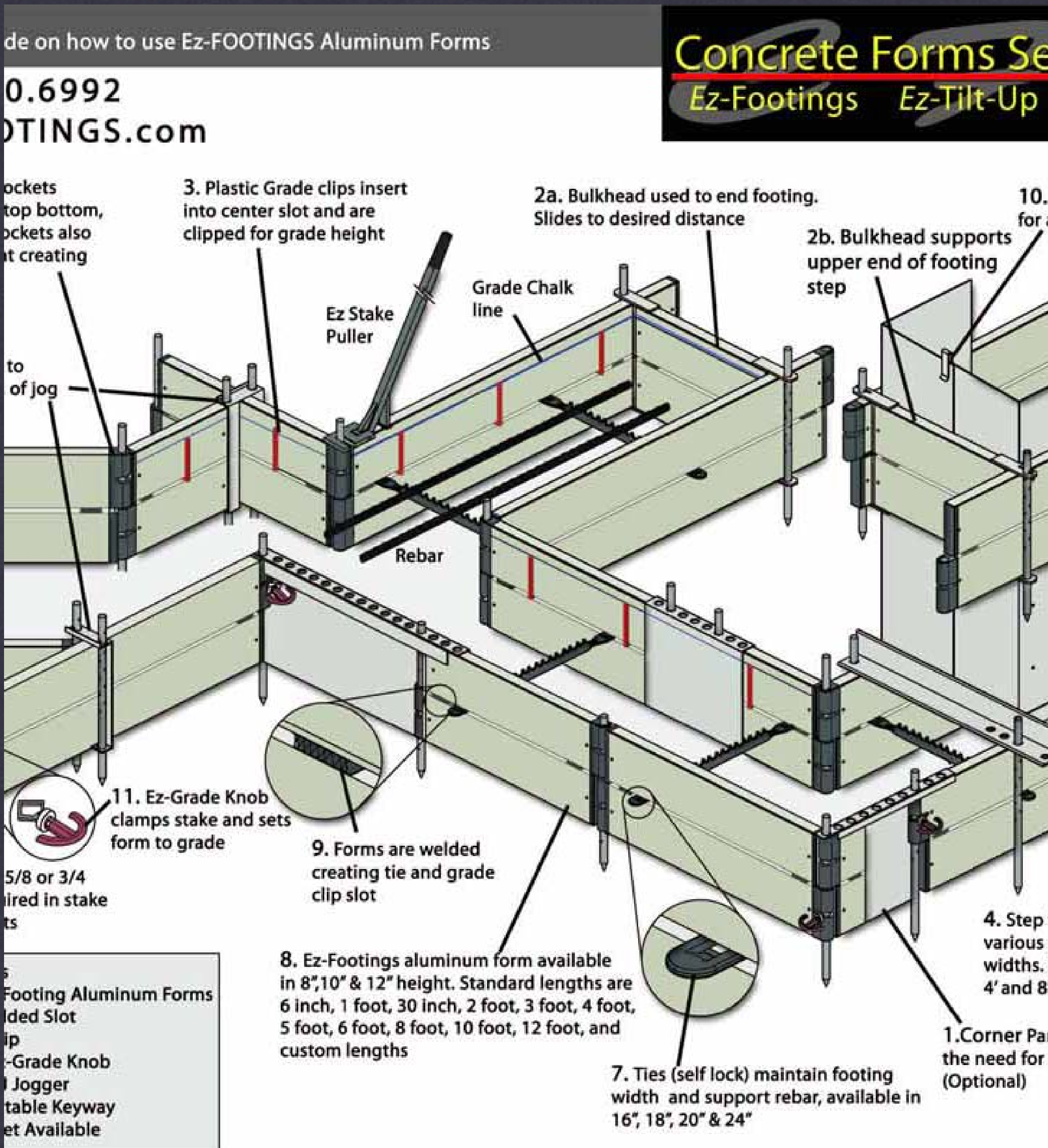
Arch 1230

CONCRETE

Professor Friedman

formwork

Arch 1230



CONCRETE

Professor Friedman

formwork

Arch 1230

CONCRETE

Formwork

Professor Friedman

Arch 1230

CONCRETE

Formwork

Professor Friedman

Arch 1230

steel bars give concrete tensile strength

CONCRETE

Professor Friedman

Arch 1230

STRENGTH IN TENSION:
0 psi

STRENGTH IN COMPRESSION:
1,000-4,000 psi

STRENGTH IN TENSION:
24,000-43,000 psi

STRENGTH IN COMPRESSION:
24,000-43,000 psi

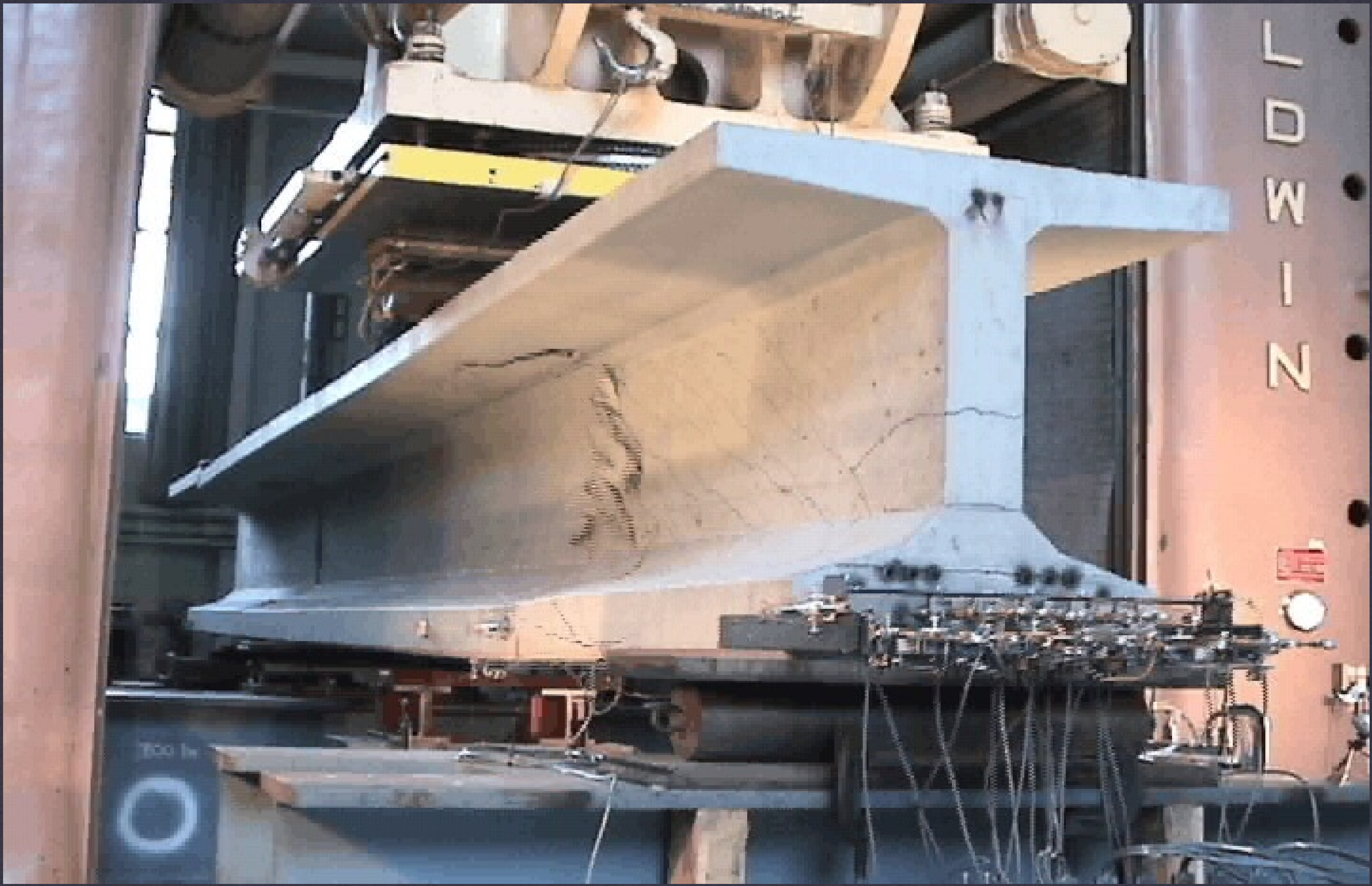
properties of concrete and steel

COEFFICIENT OF LINEAR EXPANSION: 12

COEFFICIENT OF VOLUMETRIC EXPANSION: 36

COEFFICIENT OF LINEAR EXPANSION: 11-13

COEFFICIENT OF VOLUMETRIC EXPANSION: 33-39

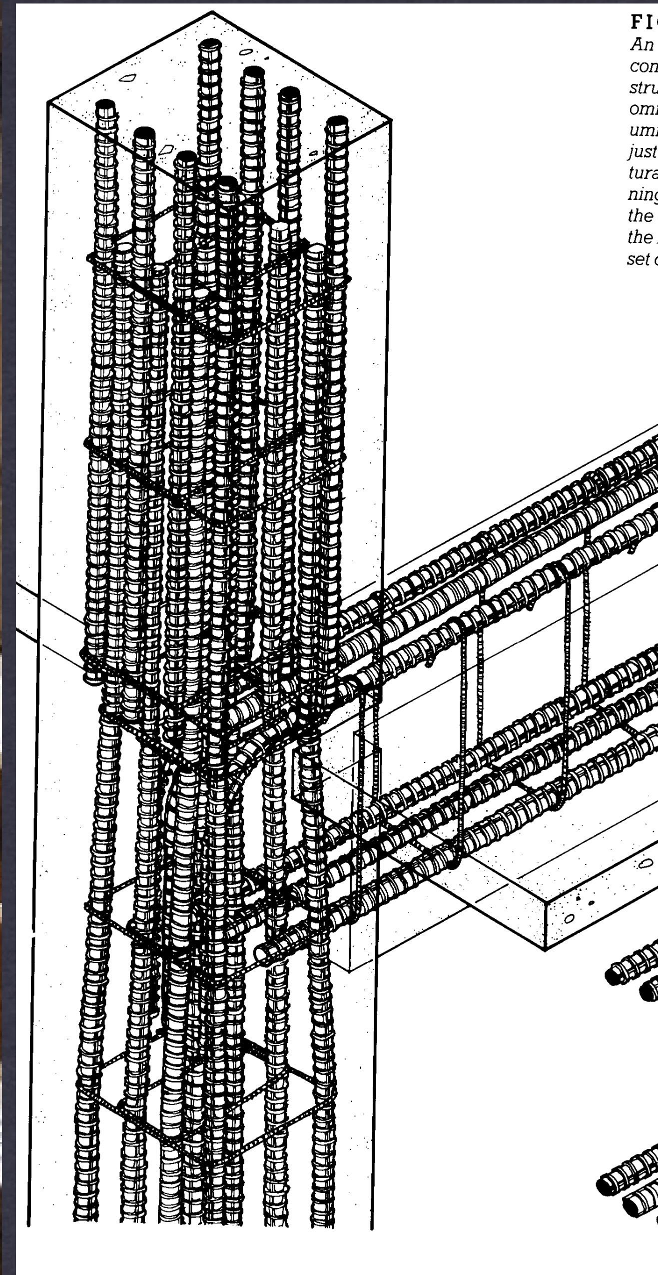


CONCRETE

steel positioning in concrete (tension)

Professor Friedman

Arch 1230



CONCRETE

steel positioning in concrete (compression)

Professor Friedman

Arch 1230

CONCRETE

types of reinforcement

Professor Friedman

Arch 1230

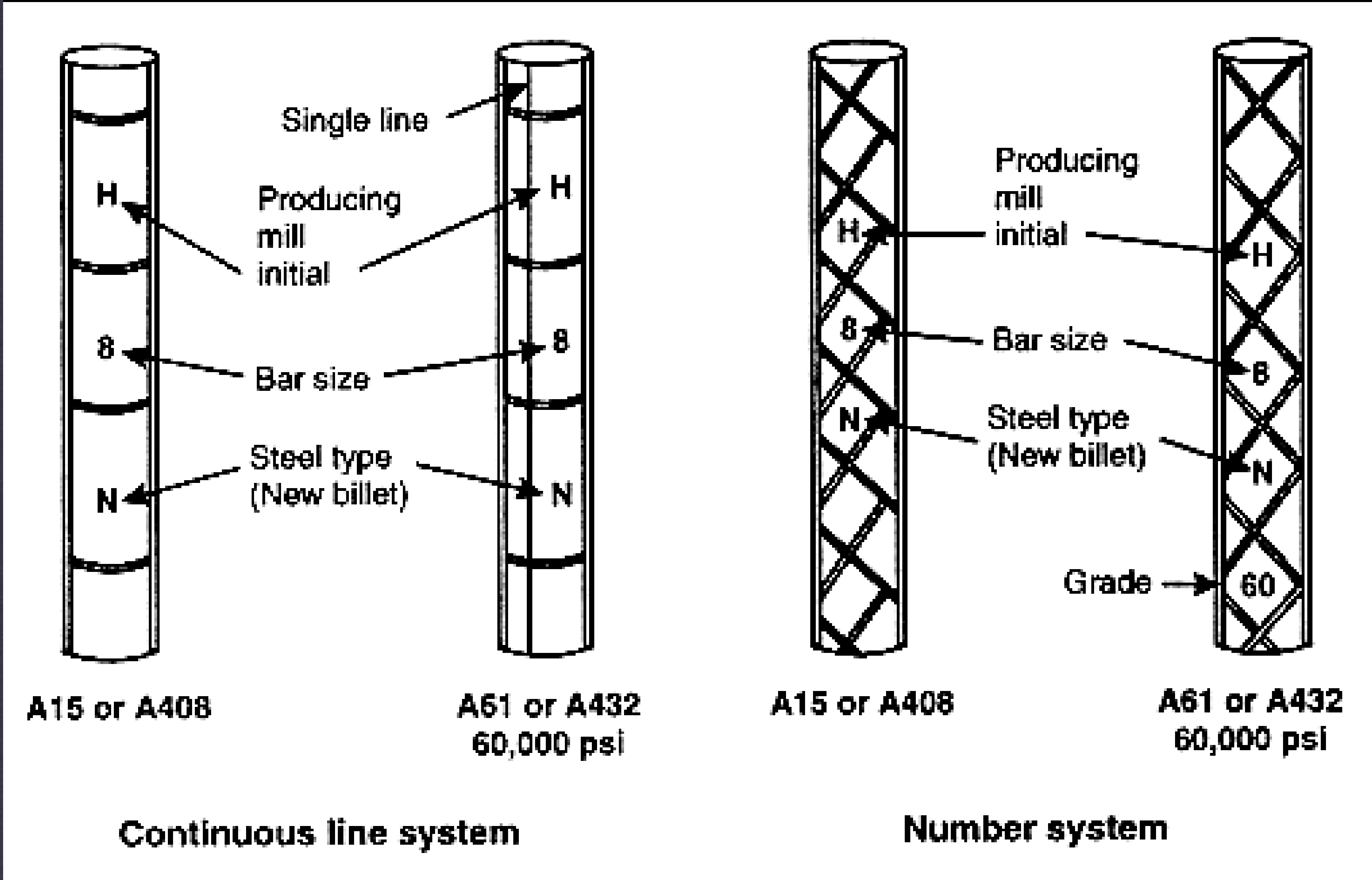
 

CONCRETE

types of reinforcement

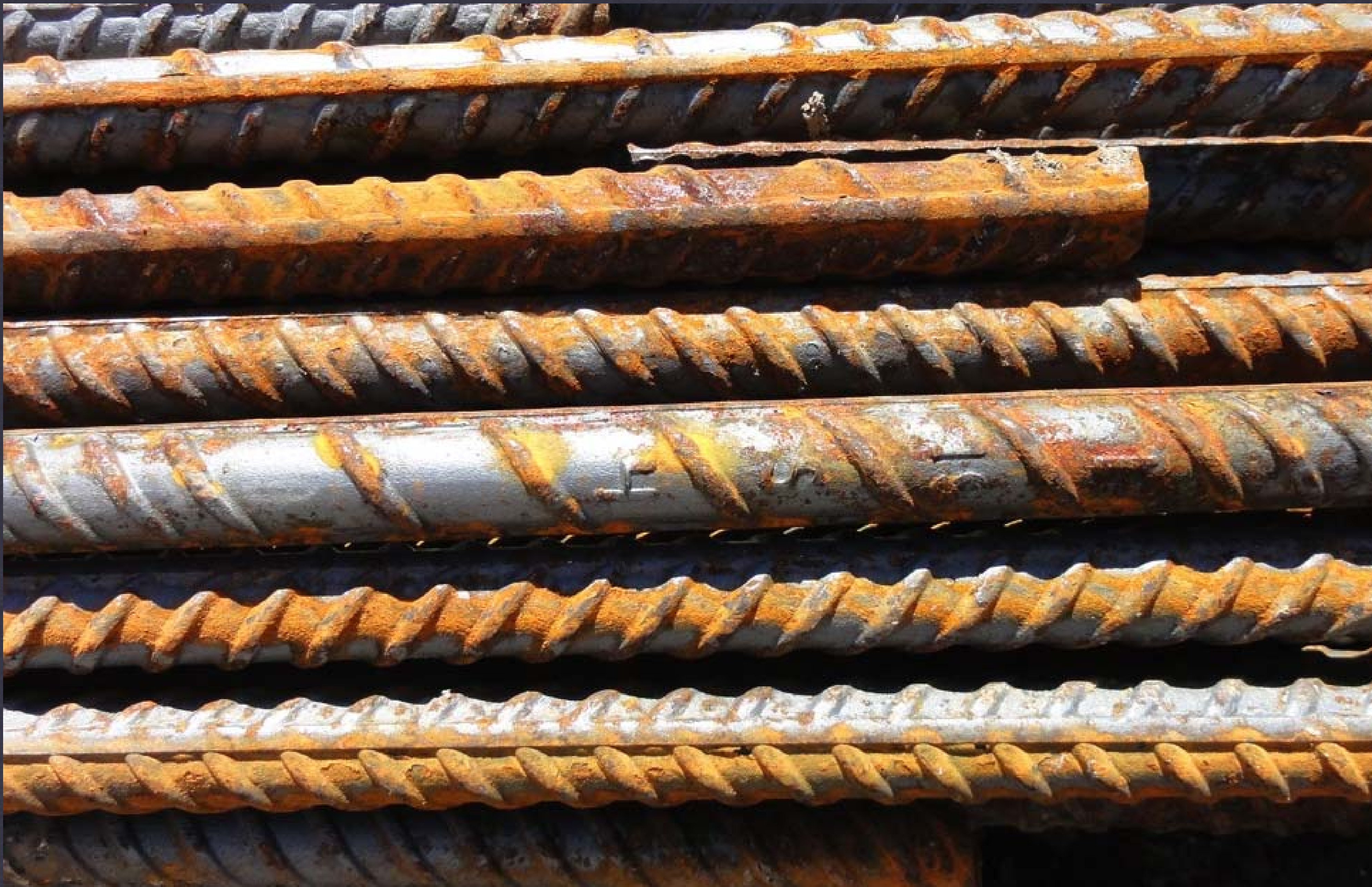
Professor Friedman

Arch 1230



CONCRETE

reinforcing bar identification marks



CONCRETE

reinforcing bar identification marks

Professor Friedman

Arch 1230

DESIGNING THE STRUCTURAL SECTION:

AREA OF STEEL REQUIRED FOR THE CONCRETE STRUCTURAL ELEMENT

DEPTH OF COVERAGE

CLEAR SPACING BETWEEN BARS

SIZE AND # OF BARS

CONCRETE

designing reinforced concrete

Professor Friedman

Arch 1230

CONCRETE

positioning / supporting the reinforcement

Professor Friedman

Arch 1230

CONCRETE

pouring the concrete

Professor Friedman

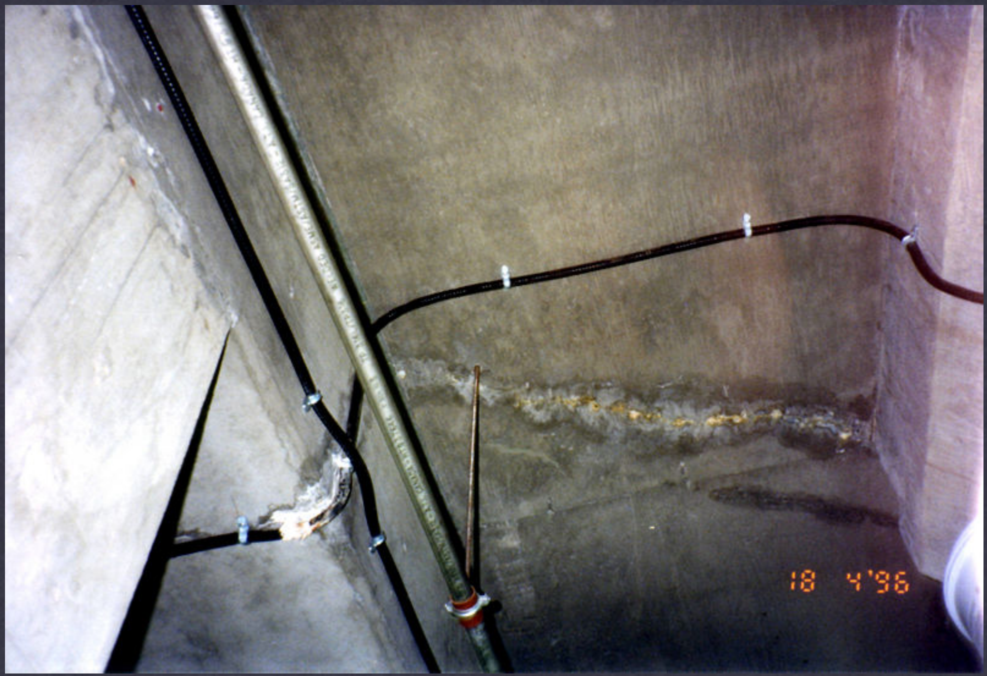
Arch 1230

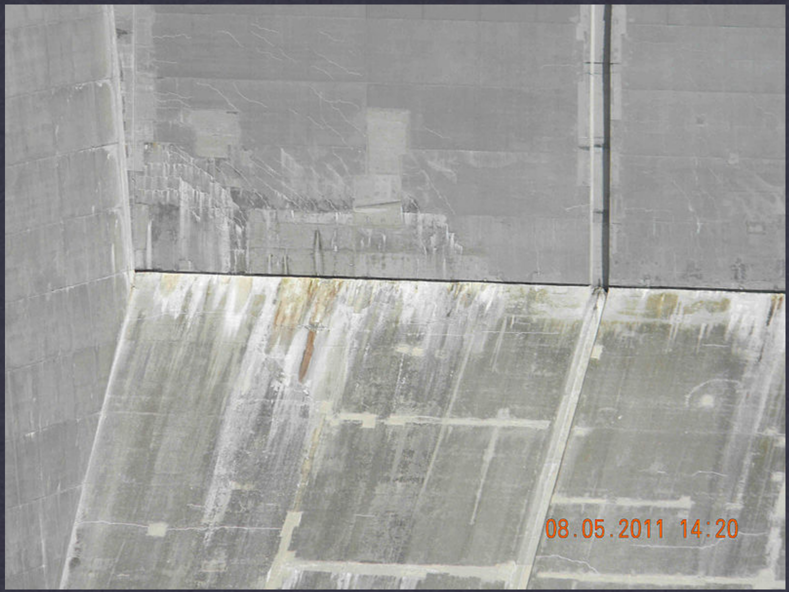
CONCRETE

coverage on the steel

Professor Friedman

Arch 1230



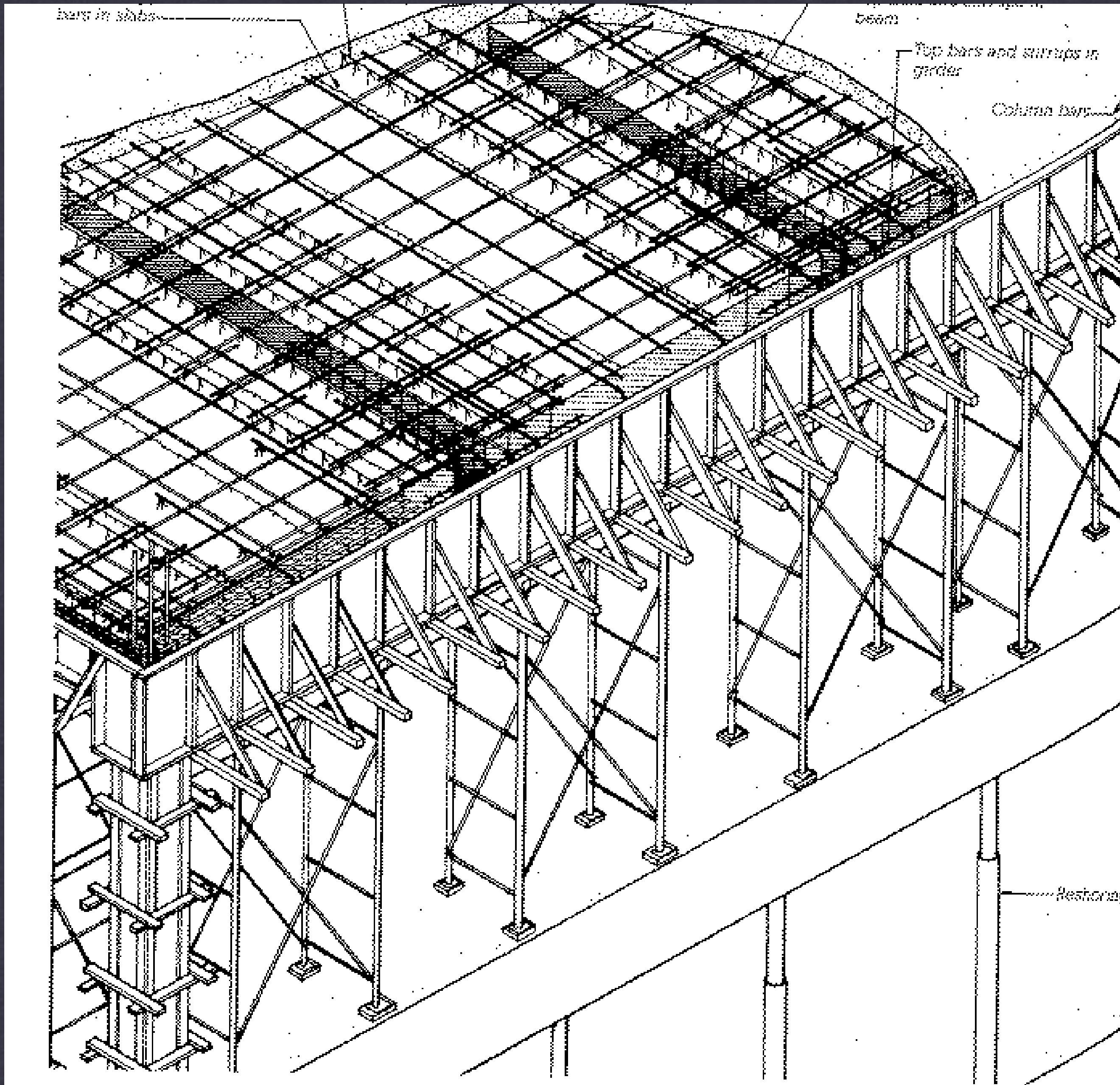


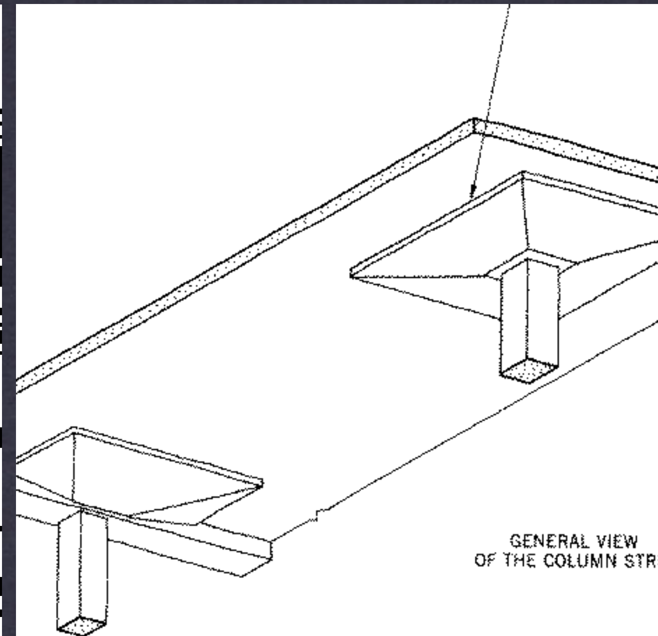
CONCRETE

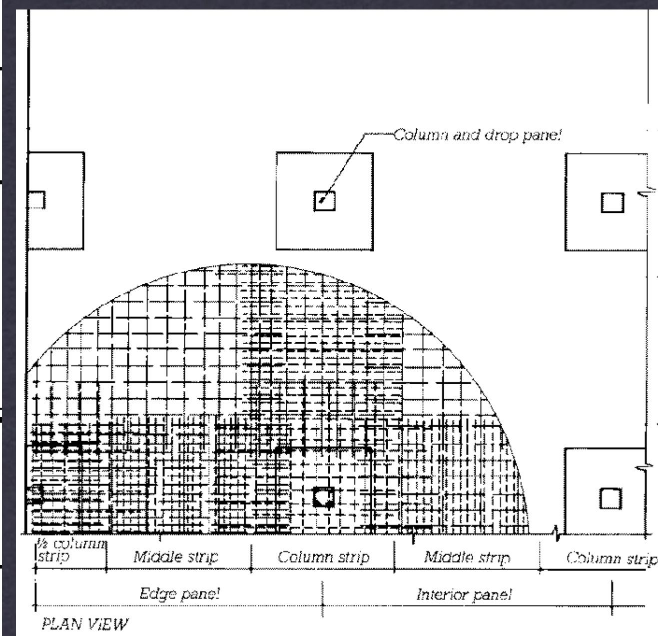
Professor Friedman

Spalling and Efflorescence

Arch 1230







CONCRETE

reinforcement reflects structural system

Professor Friedman

Arch 1230

CONCRETE

column reinforcing

Professor Friedman

Arch 1230

CONCRETE

curing concrete in harsh weather

Professor Friedman

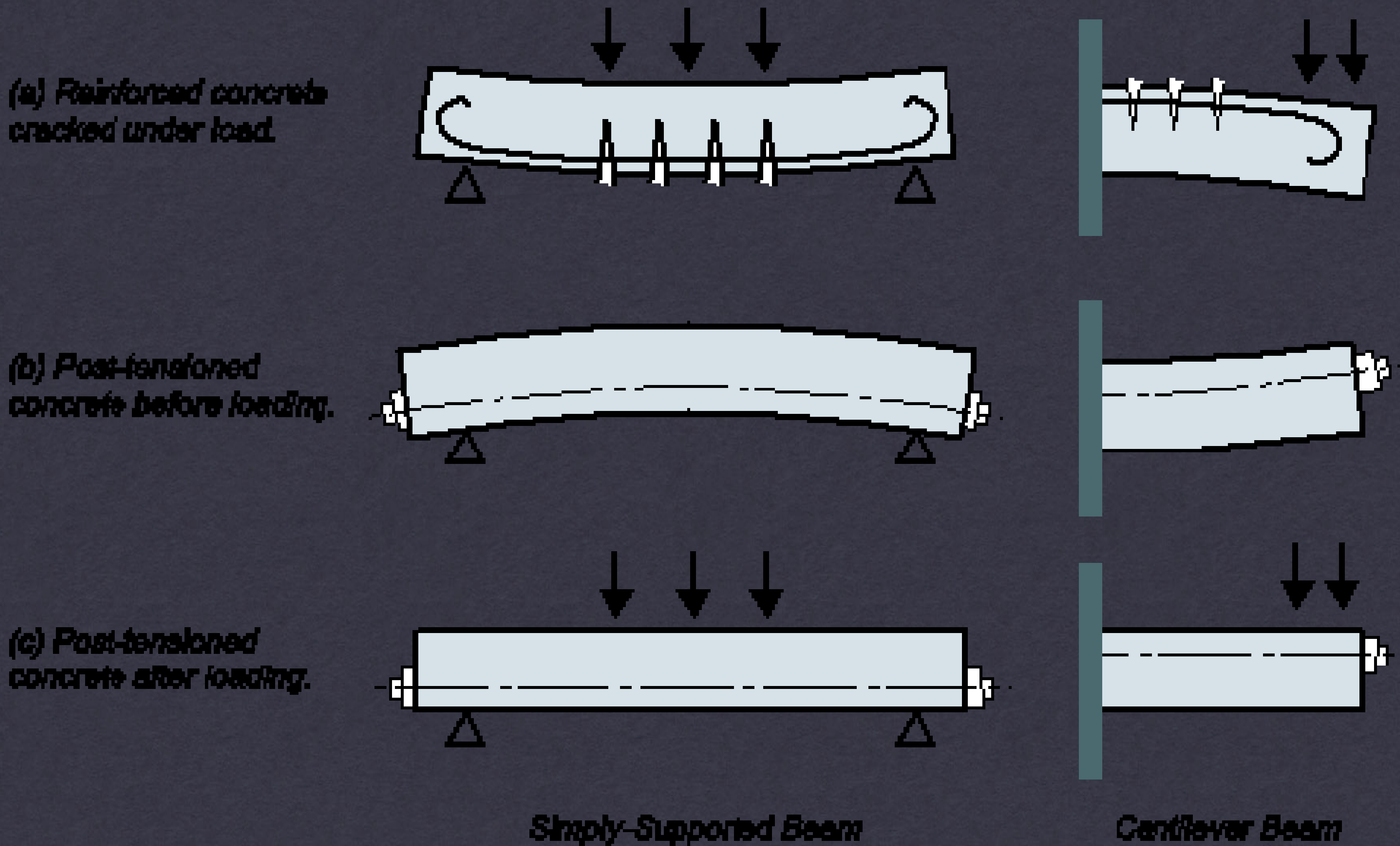
Arch 1230

CONCRETE

Professor Friedman

Creep

Arch 1230

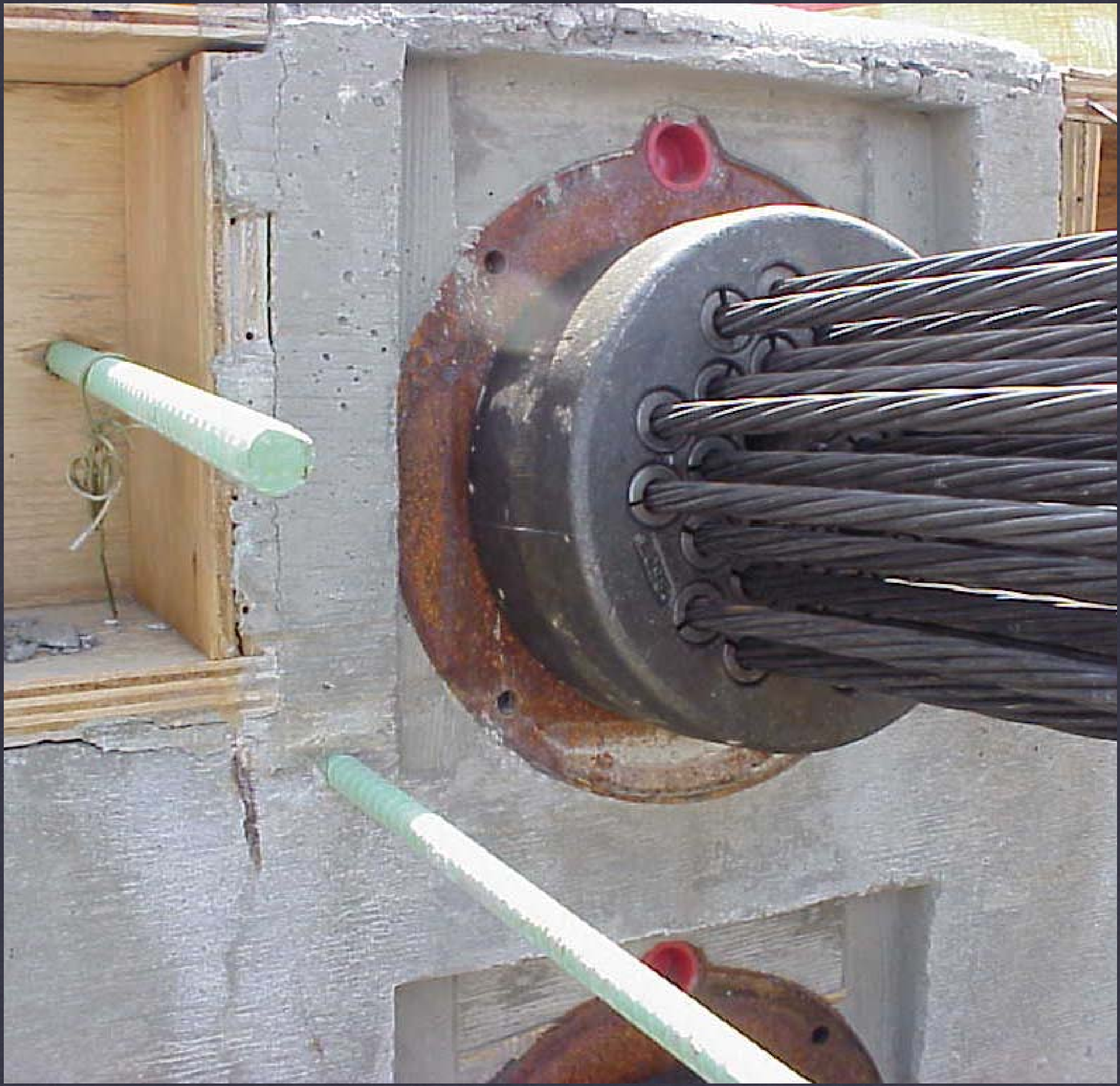


CONCRETE

prestressing concrete structural elements

Professor Friedman

Arch 1230



CONCRETE

prestressing concrete structural elements

Professor Friedman

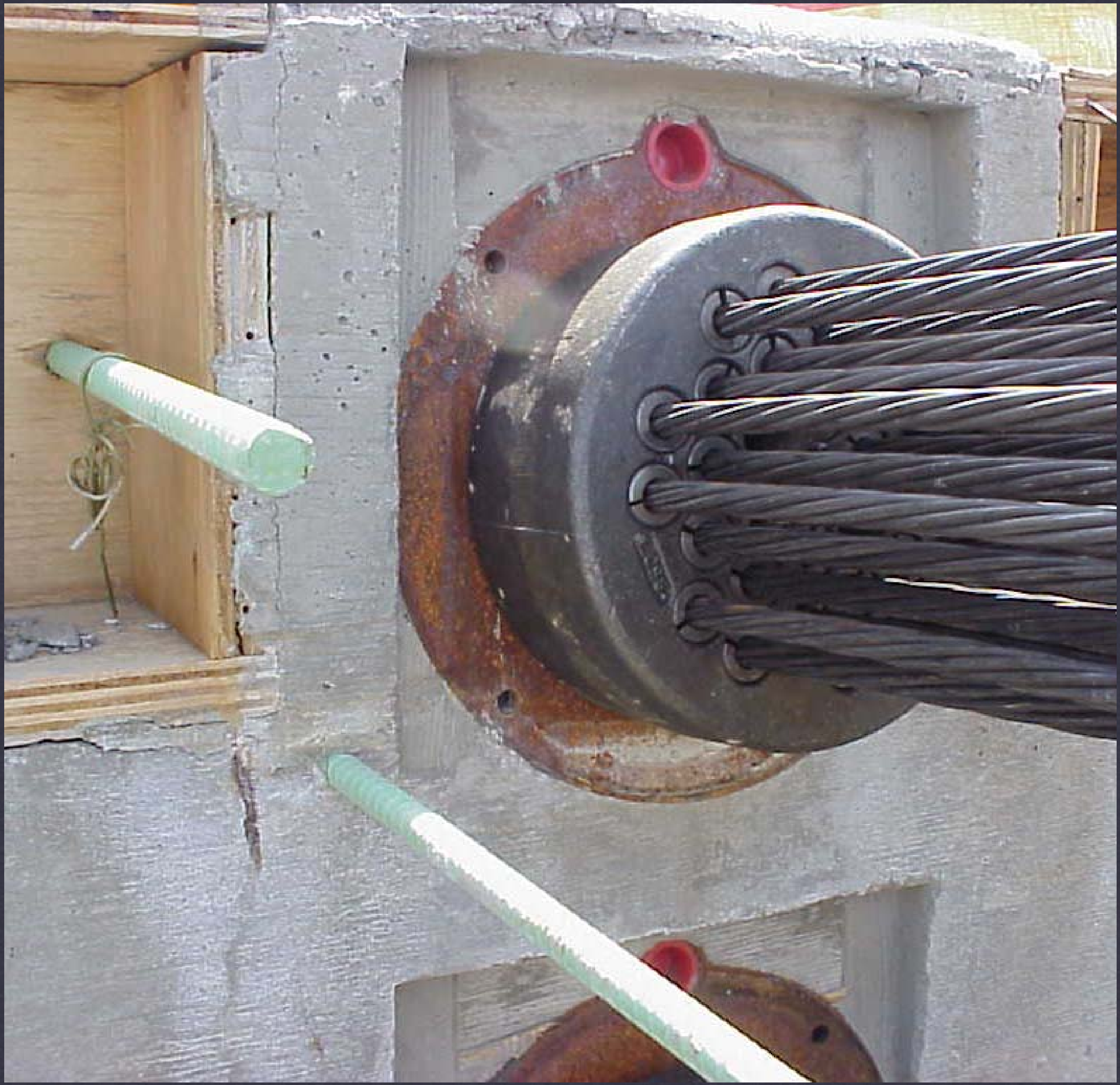
Arch 1230

PRE TENSIONING:

PRECAST CONCRETE ELEMENTS CAST AROUND STRETCHED REINFORCED (IN THE SHOP)

POST TENSIONING:

REINFORCEMENT INITIALLY PREVENTED FROM BONDING. TENSIONED WITH JACK THEN GROUTED (ON SITE)

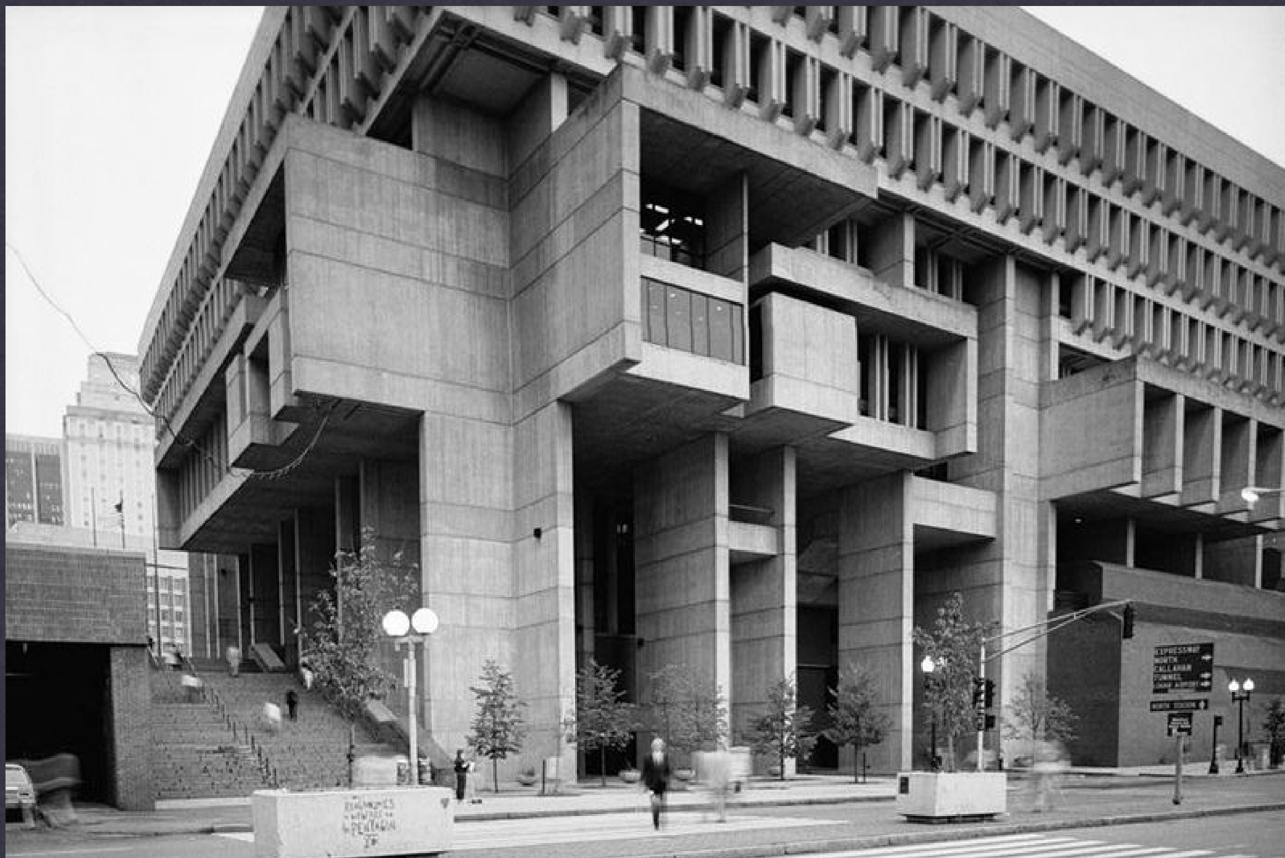


Translucent concrete

CONCRETE

Professor Friedman

Arch 1230

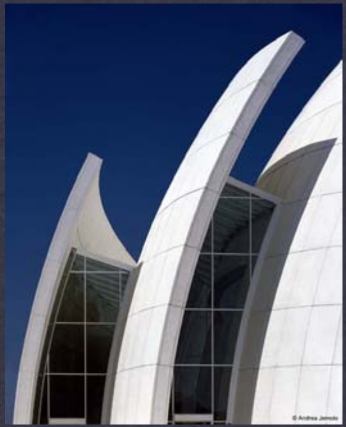


CONCRETE

Professor Friedman

Concrete case studies

Arch 1230



CONCRETE

Professor Friedman

Concrete case studies

Arch 1230

CONCRETE

Professor Friedman

Concrete case studies

Arch 1230

wrap up:

CONCRETE IS UNIQUE AS ITS FORM IS DEFINED ON SITE. CAREFULLY COMBINED WITH STEEL, IT HAS THE POTENTIAL FOR MASTERLY TRANSFORMATION

- after water, concrete is most widely used material on earth
- raw ingredients are readily available in most regions
- tools required range from primitive to advanced
- concrete does not rot or burn
- relatively low cost material
- flexible and adaptable to any use: pavement, structure, cladding, finishes