

CRSI - Building Value with Reinforced Concrete

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Greater Southwestern Regional Manager



CRSI

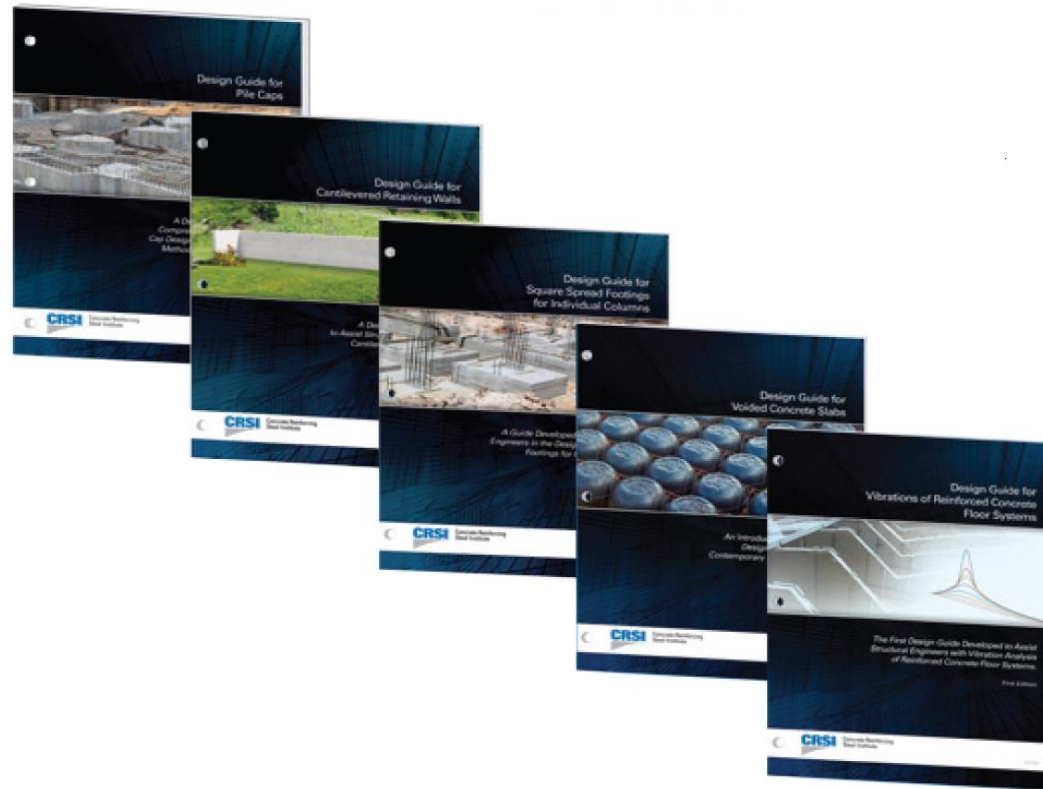
Founded in 1924

Industry Publications



Design and
Construction
Support

CRSI Design Guides



Pile Caps
Spread Footings
Retaining Walls
Economical Design
Voided Slab
Floor Vibrations

Available on

www.crsi.org

Electronic PDF

Hardcopy also available

CRSI – Tech Notes

CRSI

Technical Note

Construction Technical Note
CTN-G-2-11

Frequently Asked Questions (FAQ) About Reinforcing Bars

Introduction

CRSI routinely receives inquiries concerning various aspects of reinforcing bars, and reinforcing concrete design and construction. Most of these questions come from design professionals (engineers and architects) and field personnel (inspectors, code enforcement personnel, and contractors). The following are topic areas where we receive a majority of our inquiries:

- Field bending of reinforcing bars
- Field cutting of reinforcing bars
- Welding of reinforcing bars
- Rust on reinforcing bars
- Cover over reinforcing bars
- Epoxy-coated reinforcing bars
- Properties of old reinforcing bars
- Bar support use & types
- Tying of reinforcing bars
- Availability and application of ASTM A706 reinforcing bars

Given these general areas of inquiry, CRSI responds to the frequently asked questions (FAQ). Specific questions and responses are provided below.

When and how is it acceptable to bend steel reinforcing bars in the field?

The engineer of record (EOR) for the project should specify and/or approve the acceptability of field bending, straightening, or re-bending of reinforcing bars. Section 7.3.2 of the ACI 318 Building Code (2008) prohibits all reinforcement partially embedded in concrete from being field bent, unless specifically shown on the design drawings or expressly permitted by the licensed design professional.

Section Practice (2 the rebar) bedded in c #19) bars c

(Note: T jobsite to f time basis condition is fabrication, some local However are partially configured I dislodging, times they r tion accident by a truck, because th moved. An) In some severe, and appropriate ing new ad substrate is base of the undamaged the bar exit Field re where reinl then field r dition of th and can les EOR. Fabri of reinforc darts for m do not rewl and subset compromise steel, even not be visib

CRSI

Technical Note

Engineering Technical Note
ETN-C-1-10

Economical Reinforcing Concrete Construction

Introduction

Experience has shown that the initial cost of reinforced concrete structures can be reduced through planning and detailing in such a way as to minimize the expenses activities associated with materials and the construction activities associated with formwork, reinforcement, and concrete. Frequently, these cost-reducing techniques are not obvious to the designer. For example, formwork costs are generally 40 to 60 percent of the completed reinforced concrete structure. Material costs for concrete and reinforcement are on the order of 10 to 30 percent. The labor cost percentage for placing the concrete and the reinforcement is the remainder. This technical note addresses many of the areas that have shown to result in overall cost savings.

Formwork

Select one framing system and use it throughout the structure. For each framing system used, a separate forming system will be necessary. This means additional costs associated with the formwork and its mobilization, as well as a learning curve for the construction personnel will be incurred. As a result, experience has shown that it is difficult to economically justify the use of more than one framing system when construction usually occurs on large structures when the construction changes over the building height, such as a high-rise with a multiple floor parking garage in the lower floors and residences in the upper floors.

Arrange and organize structural members to fully utilize structural capacity. The thickness of floor slabs may be governed by the fire rating specified by the building code, required fire rating specified by the building code, so span the slab as far as practical (considering deflection) with the minimum amount of reinforcement. Another basic structural member frequently underutilized is the concrete wall. Concrete walls normally have to be of a minimum thickness and provided with a minimum amount of reinforcement.

ment. The walls or int axial loads, overall stru girders whe

Use concrete associated with tural details offset the a is eliminate routinely co finishes. Sir and sealed examples it exposed ce may utilize i high quality

Orient i span the s tire structu tures that at members o out the ent most effice and fewer i multiple fra

Use mo lar forms h walls or floo large secto to 20 times) tems have l used to cas tary forming in more cu formed elev exterior wa can be just incurred wh A unique st be justified

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Technical Note

Construction Technical Note
CTN-M-1-11

Field Inspection of Reinforcing Bars

Introduction

In an ideal world, quality control or inspection to assure compliance with project drawings, standards, material standards, and project specifications would not be necessary because building codes would not be necessary because the project drawings and project specifications would be complete without errors or omissions, the materials would be manufactured exactly to the material standards, and the field workmanship would be precise. However, in the real world, inspection programs are recommended, with quality control programs usually mandated to ensure compliance with a regulatory agency's policies. Why is this necessary?

Project drawings are not always complete due to an owner's desire for a rapid start and completion of a project. Materials may not meet the standards due to variations in the raw material or the manufacturing process. Workmanship is not always accurate due to improper training, inadequate experience, or careless supervision. Thus, there is recognition by owners, contractors, architects/engineers, and regulatory agencies that a program for quality control and inspection are necessary to ensure compliance with the contract documents and the building code applicable to the project under construction.

The benefits of a quality control program and mandated inspection are mainly monetary, but they also ensure structural safety and compliance with architectural requirements. The owners, private and governmental, benefit with lower total costs, on-time construction schedules, and quick occupancy. The architect/engineer benefits in knowledge that the contractor, his subcontractors and suppliers, and all of their employees will benefit in a similar manner. The public, as the ultimate consumer and user of the structure, benefits in the knowledge that the structure has been built according to the project drawings and specifications.

* See the Terminology section on Page 7 for definitions of certain terms used in this report.

The improper placement of reinforcing steel can greatly affect the strength and service life of a structure. This could lead to reduced structural performance, whereby the structure can no longer be used in the manner in which it was intended. In the transportation field, where the concrete elements are exposed to the environment, costly repairs and early replacement of structures have been too common and are often caused by improper reinforcing steel placement. A better understanding of the reasons for proper reinforcement placement and how to inspect reinforcement in the field will hopefully reduce the need for costly repairs and possible early replacement of structures falling short of their service life.

Inspector Qualifications

Inspectors are individuals qualified to perform the inspection tasks. Through education, training, and experience, they should have the ability to read and understand project specifications, material standards, project drawings, and building code requirements. In the event of field problems, they must work with the contractor and make decisions on improvised details if the architect/engineer is unavailable to provide direction. An inspector must project confidence in his decisions and should be meticulous, correct, fair, and firm. He should be able to compromise when faced along with the ability to compromise when faced with a dispute regarding a conflict in the contract documents or actual field conditions, or both.

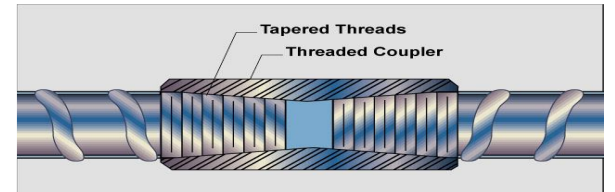
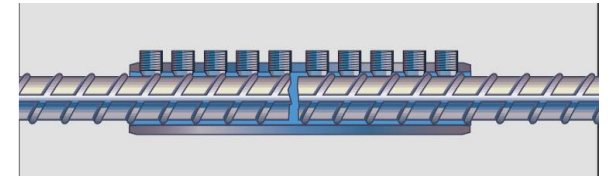
Inspection Goals

The goal of any inspection or quality control program is to ensure that the intent of the contract documents is met and the applicable requirements of the building code are followed. Inspection and testing by themselves do not add quality to the product or the material being inspected, but only confirm whether or not what is being inspected meets the criteria established by the project drawings, project specifications, and building code.

Quality during the construction process is achieved almost entirely by the contractor's quality assurance program, which depends on

CRSI - Members

- Producers of Reinforcing Steel
- Fabricators of Reinforcing Steel
- Placers of Reinforcing Steel
- Suppliers of related products & services



CRSI Honor Awards

Call For Entries



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The 2016 CRSI HONORS program is open to all project team members including owners, designers, builders and structural material suppliers.

Eligible structures utilize reinforced concrete system and must be between January 1st,

COMPLETE PROGRAM DETAILS AVAILABLE AT HONORS.CRSI.ORG

Entries can be submitted online or by mail and there is no limit on entries. Categories include all major building uses and concrete bridge types.

NEED ASSISTANCE?
For information or support with your project submittal please contact Dave Mounce, Director of Communications at 847-517-1200 ext. 303, or at dmmounce@crsi.org.

For complete entry information or to submit today visit

HONORS.CRSI.ORG.

Concrete Reinforcing Steel Institute

33 North Plum Grove Road | Schaumburg, IL 60197 | Tel: 847-517-1200 | www.crsi.org
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CRSI Assistance



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Topics for Discussion

Rebar Fabrication

Fundamentals of Reinforced Concrete

Economics of Concrete Buildings

Innovative Systems

Rebar Fabrication



Inventory



Shear Line



Table Bending



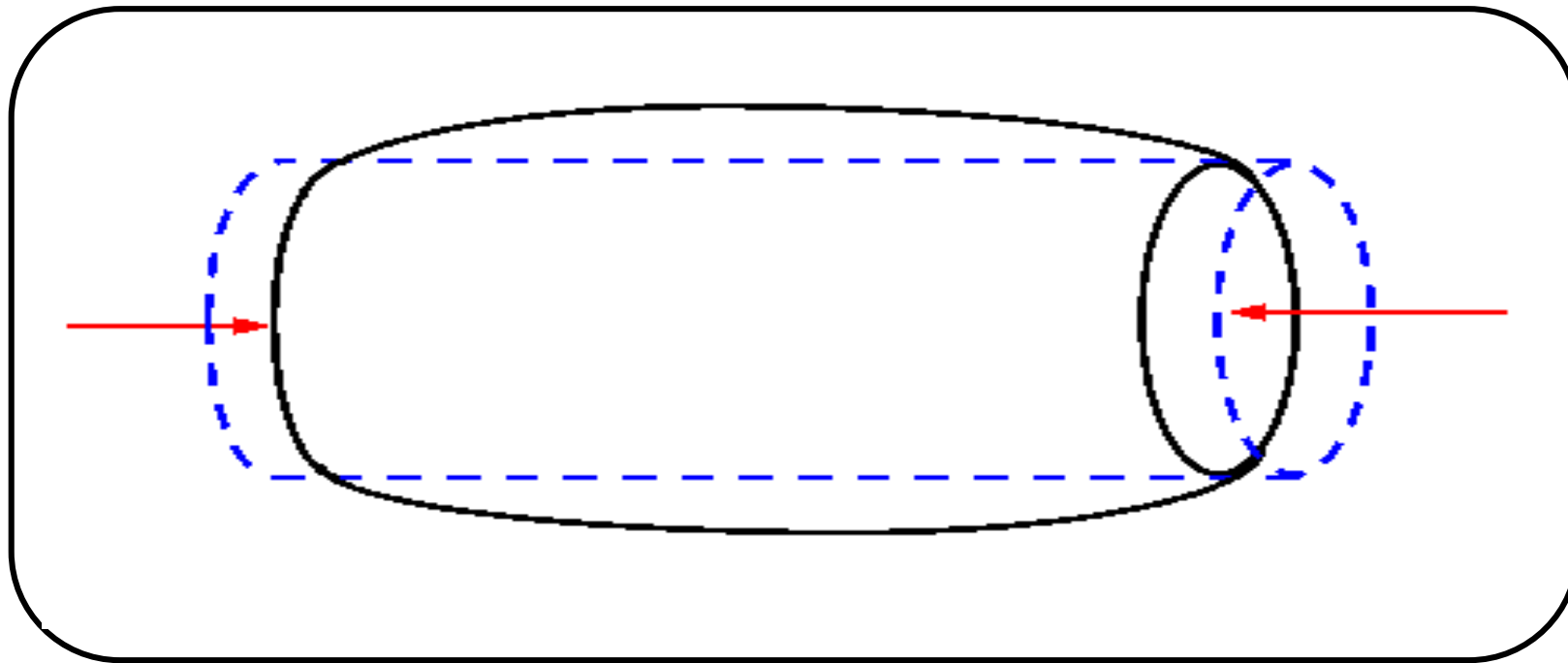
Manual Bending

Auto Bending



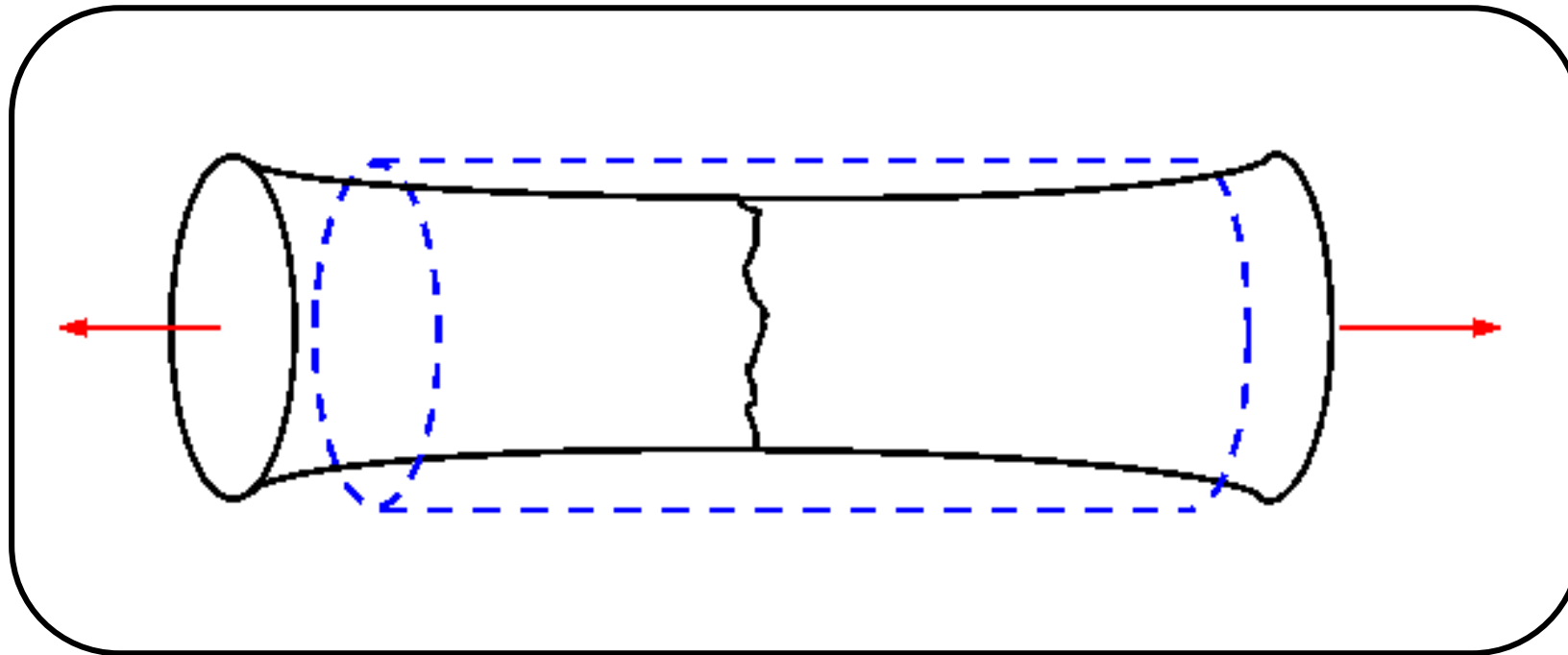
**Automatic (Coil)
Bender**

Unreinforced Concrete



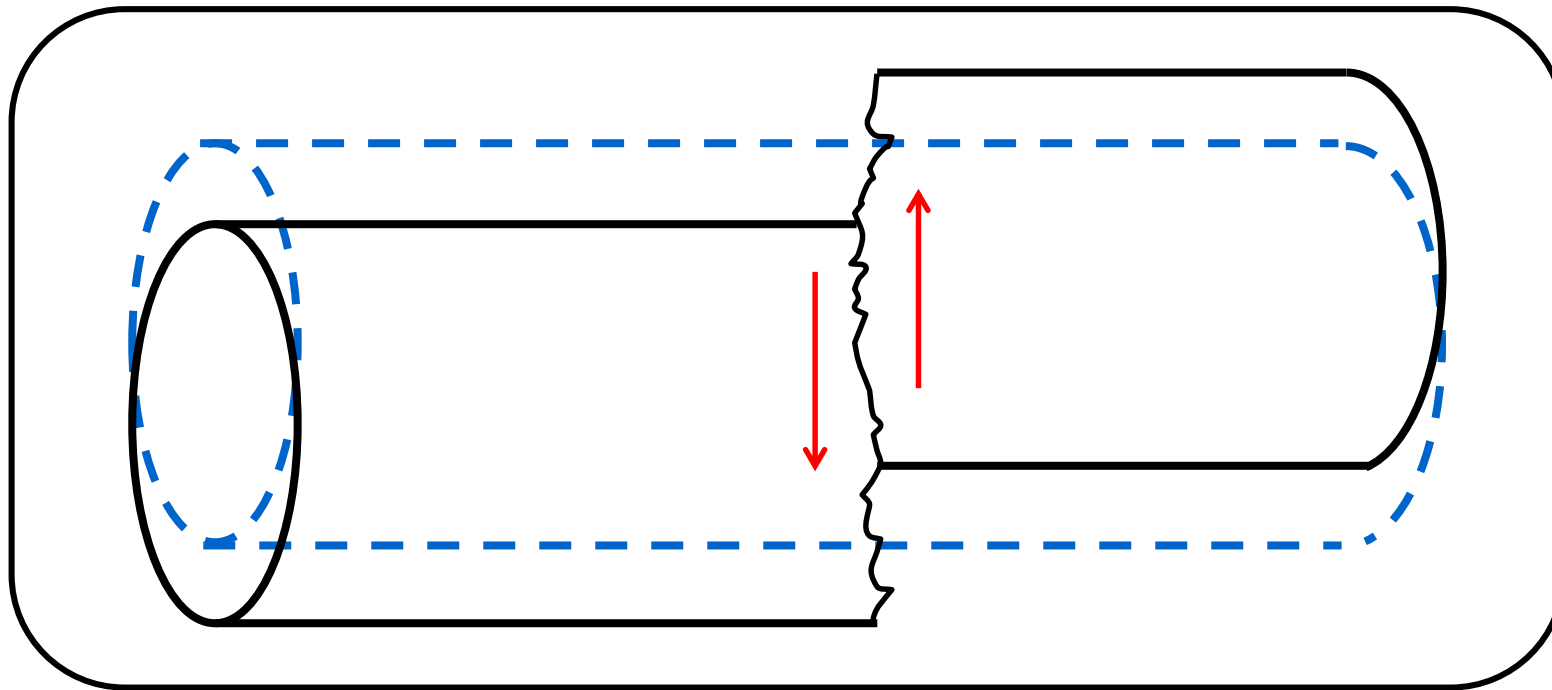
Strong in compression

Unreinforced Concrete



Weak in tension

Unreinforced Concrete



Weak in shear

Reinforcing

Performs in compression

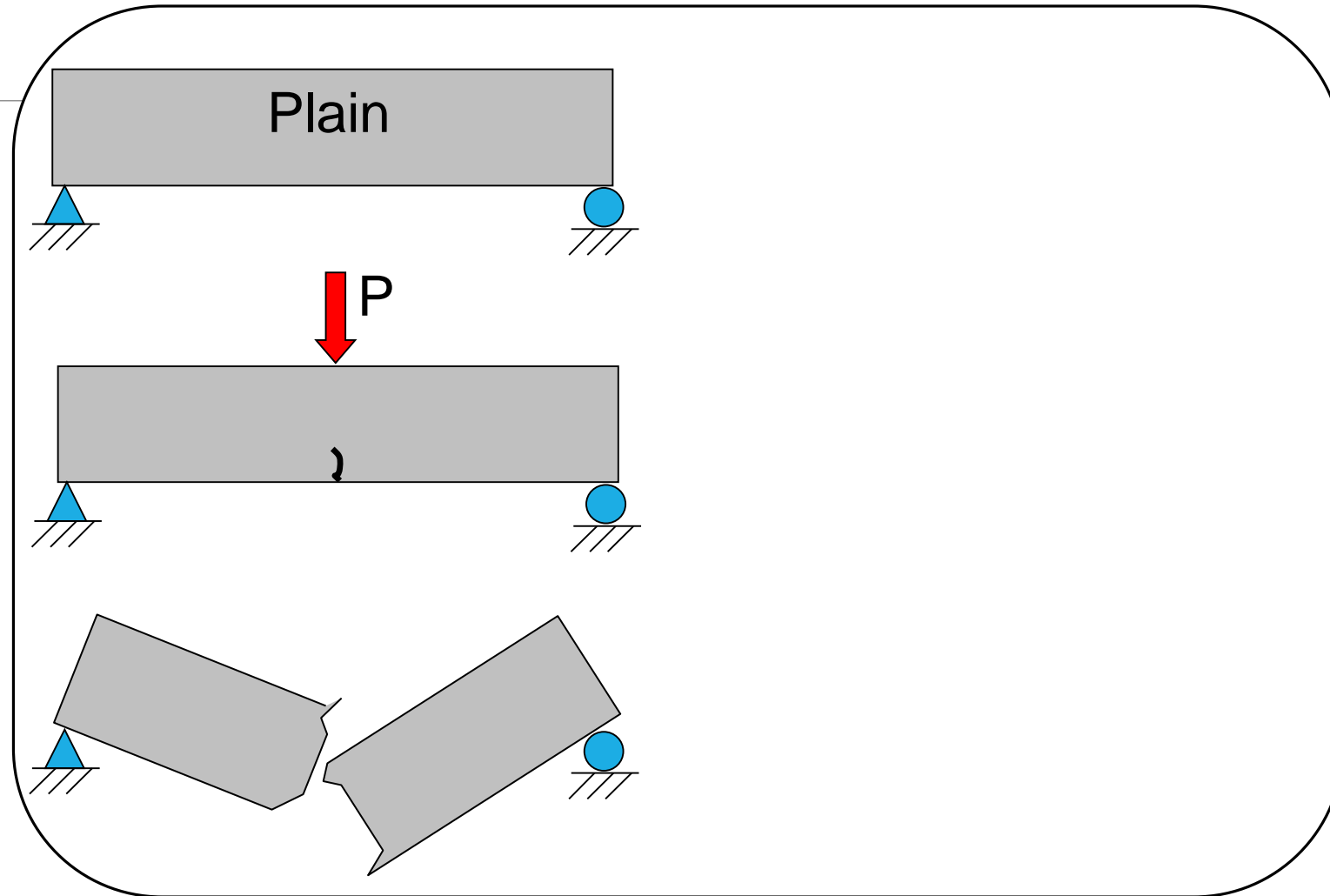
- Must be properly confined

Excellent in tension

Extremely ductile

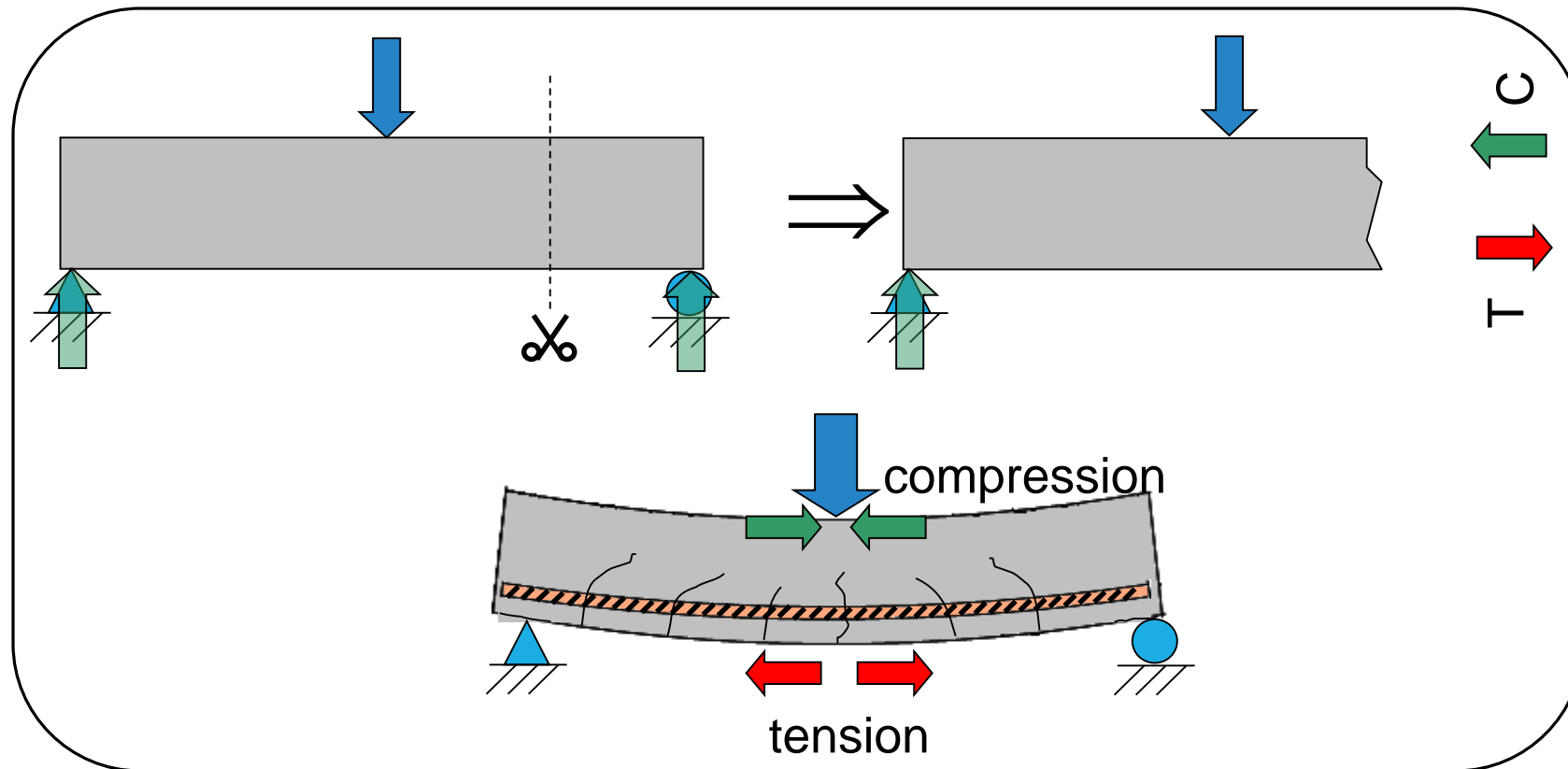


Basic Beam Theory



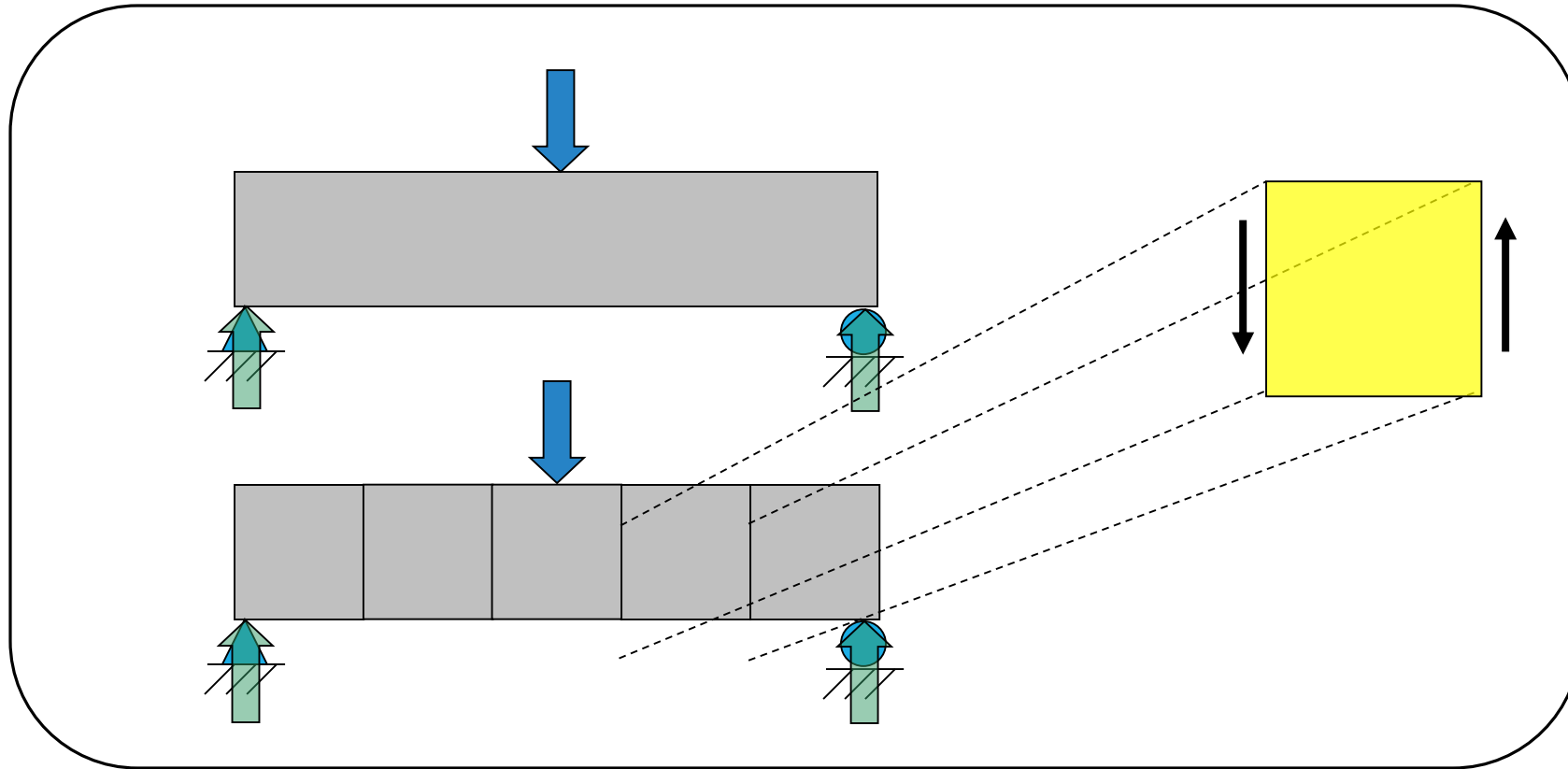
Placement of Reinforcement

Anywhere concrete might be in tension ► FLEXURE



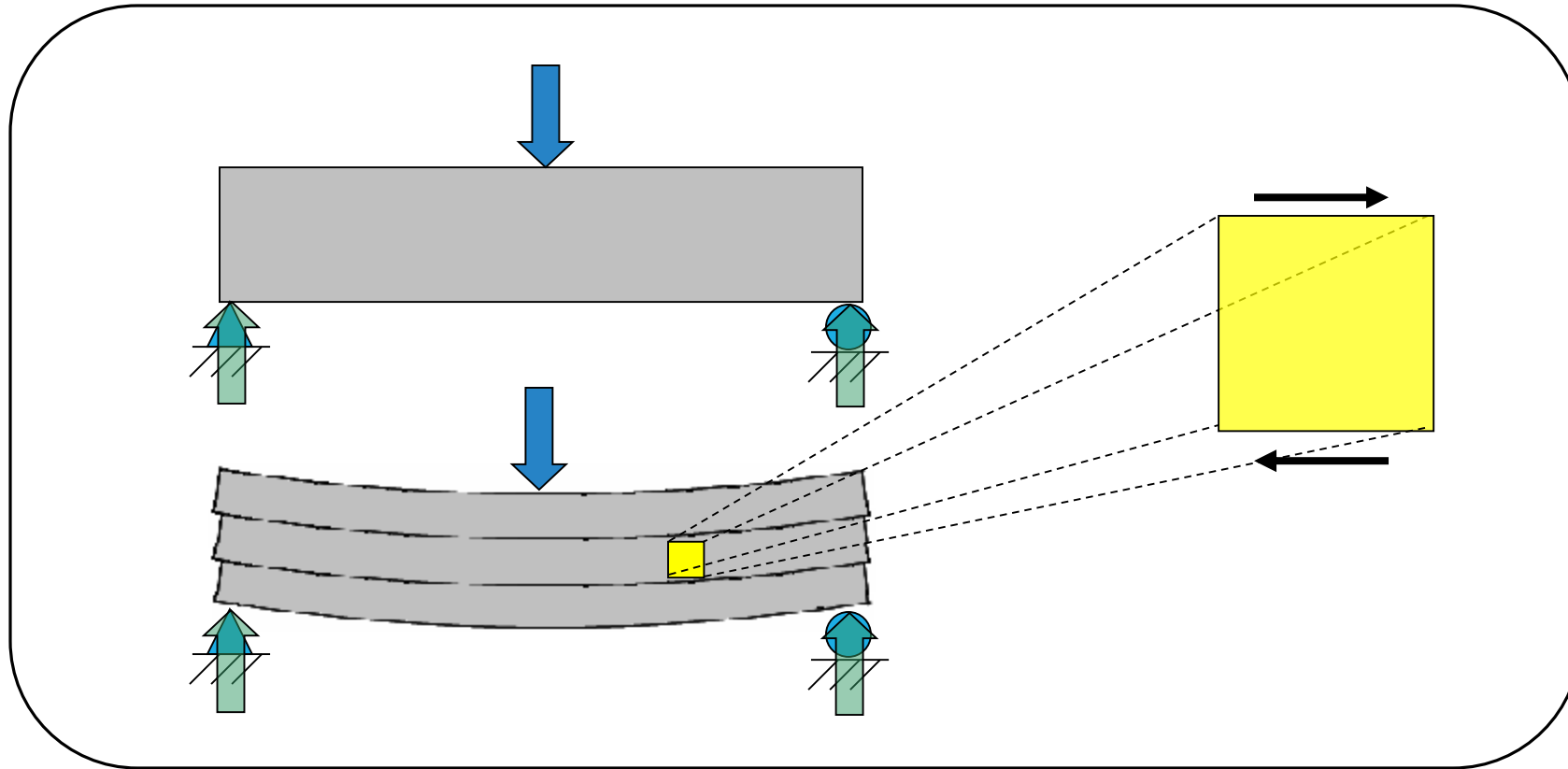
Placement of Reinforcement

Anywhere concrete might be in tension ► VERTICAL SHEAR



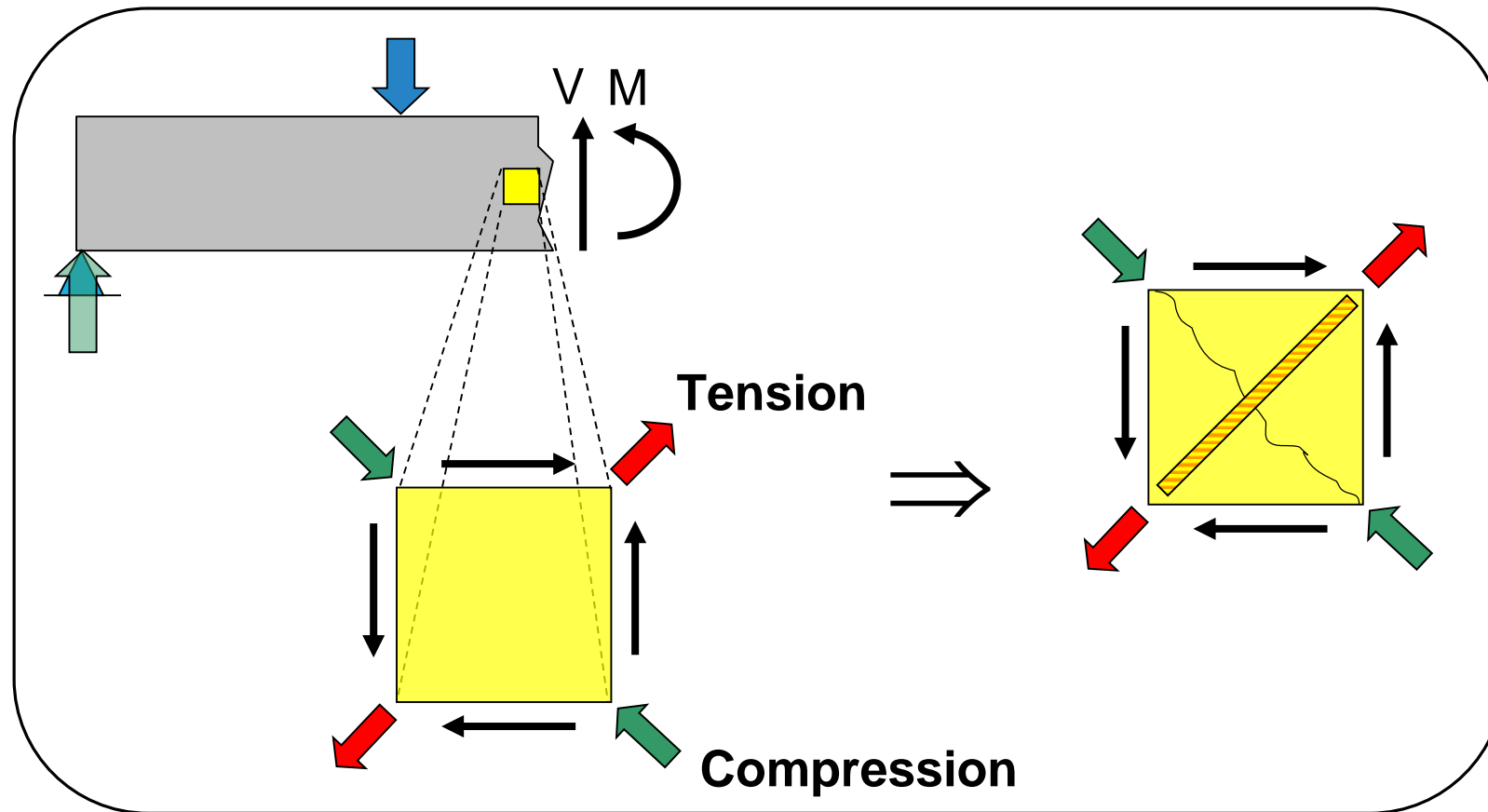
Placement of Reinforcement

Anywhere concrete might be in tension ► HORIZONTAL SHEAR



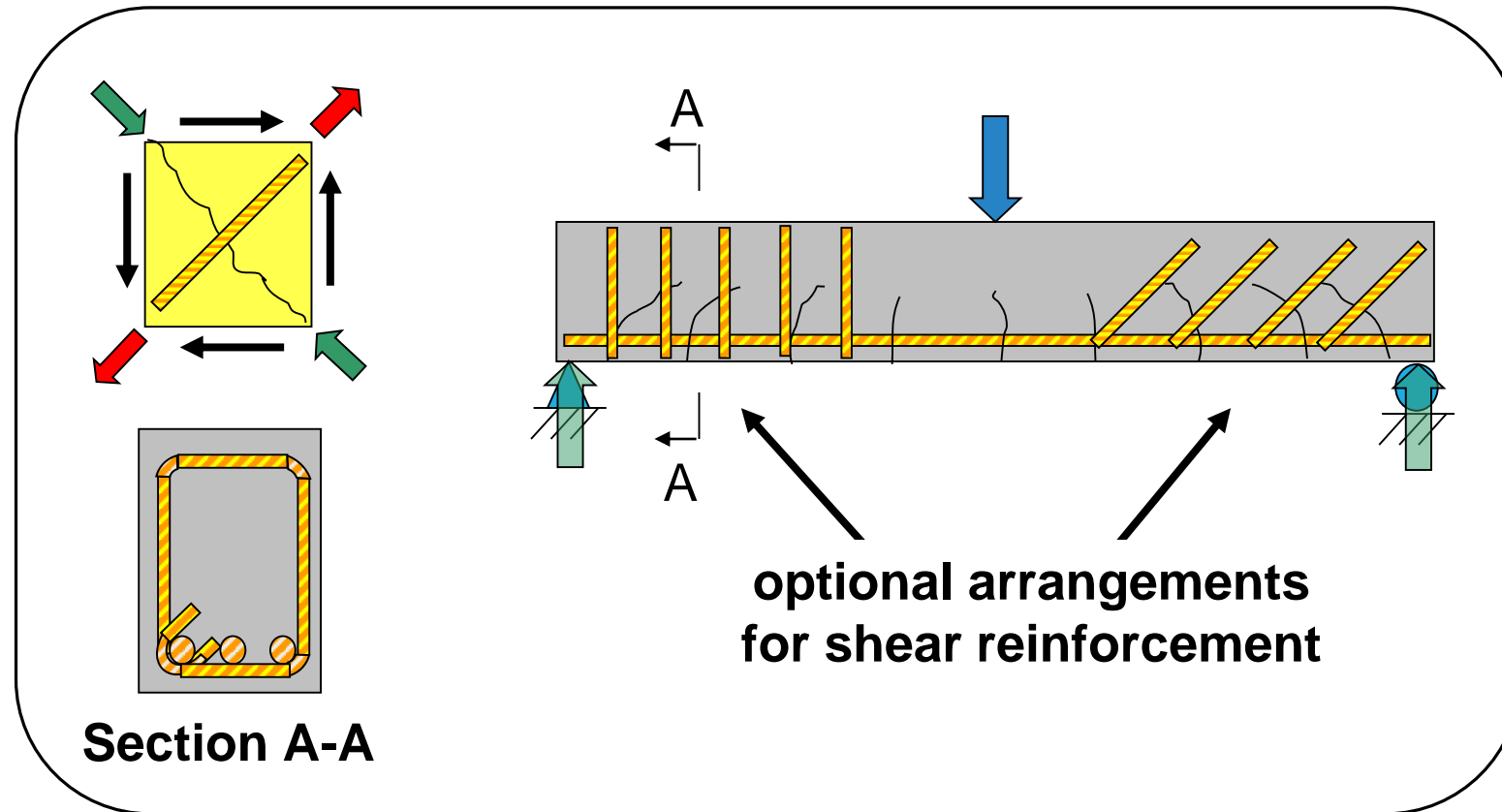
Placement of Reinforcement

Anywhere concrete might be in tension ► **COMBINED SHEAR**

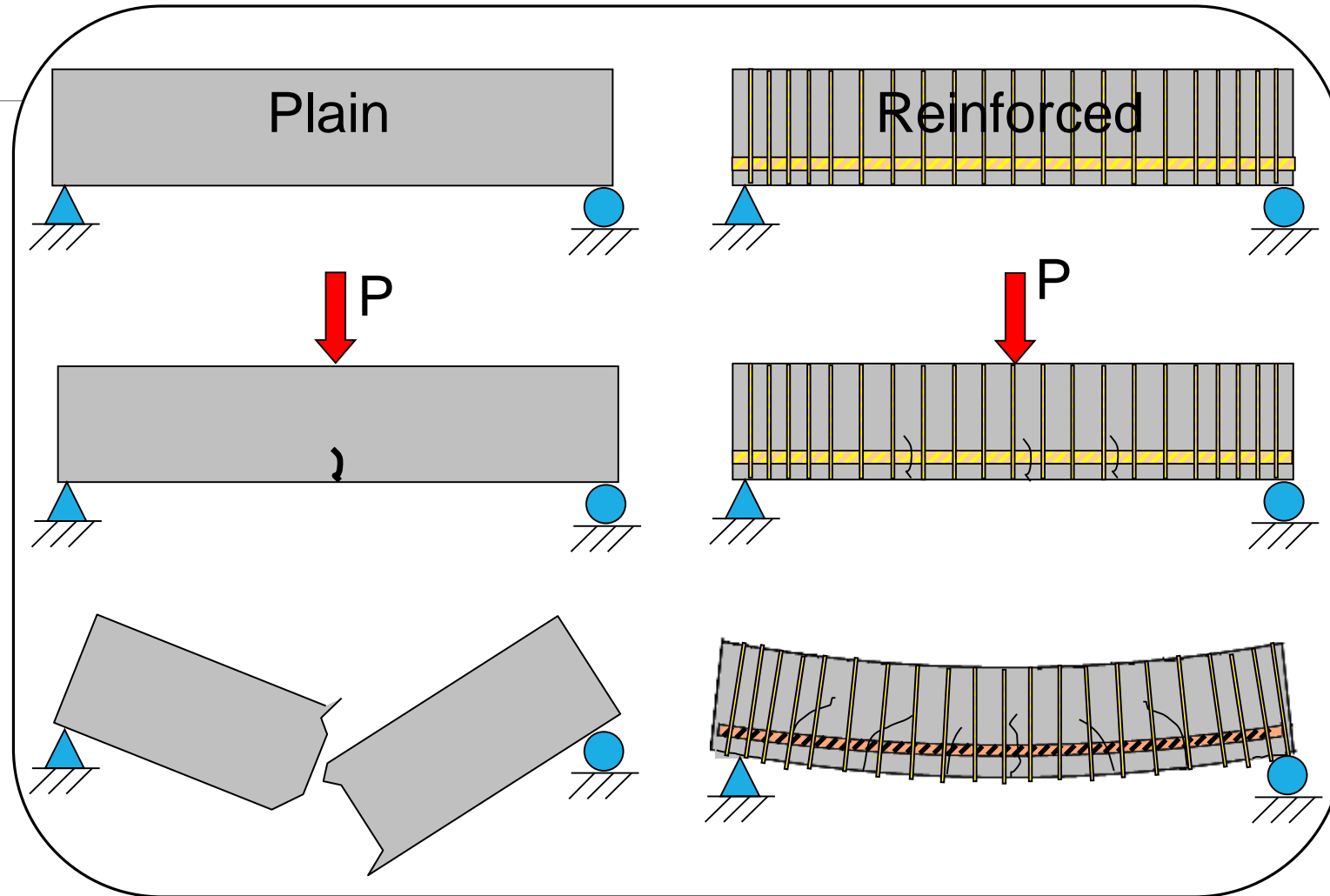


Placement of Reinforcement

Anywhere concrete might be in tension ► COMBINED SHEAR

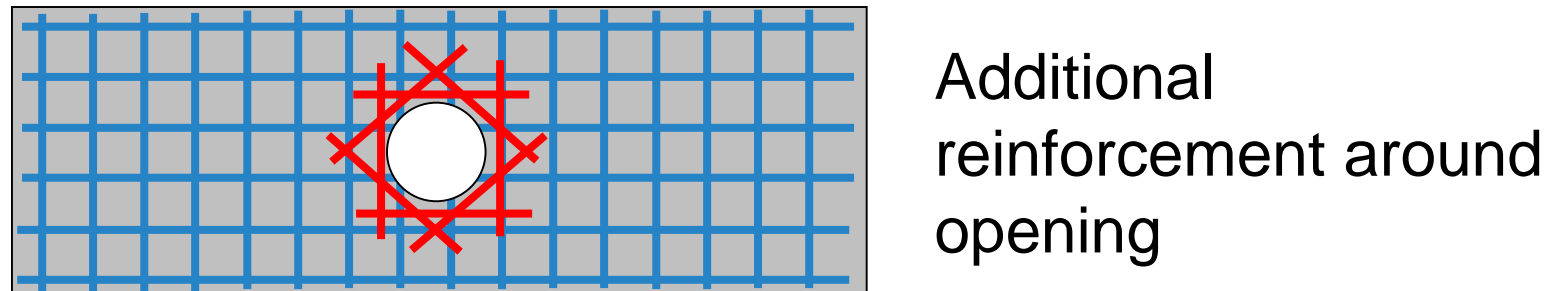
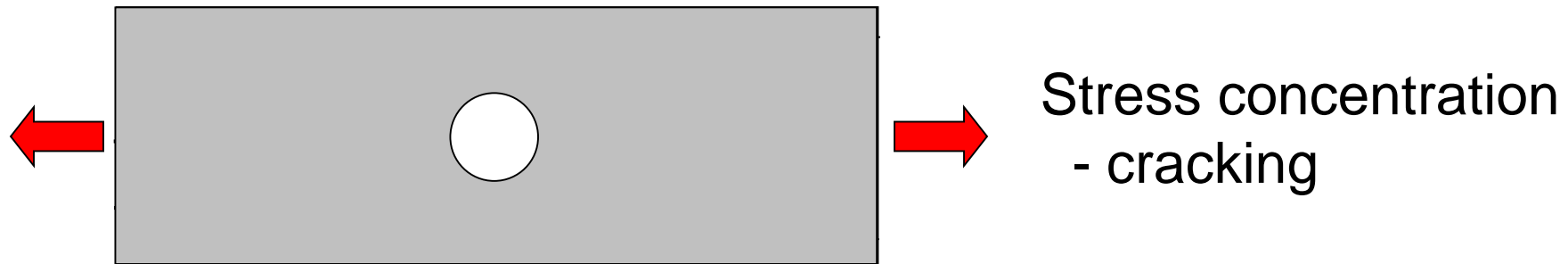


Basic Beam Theory



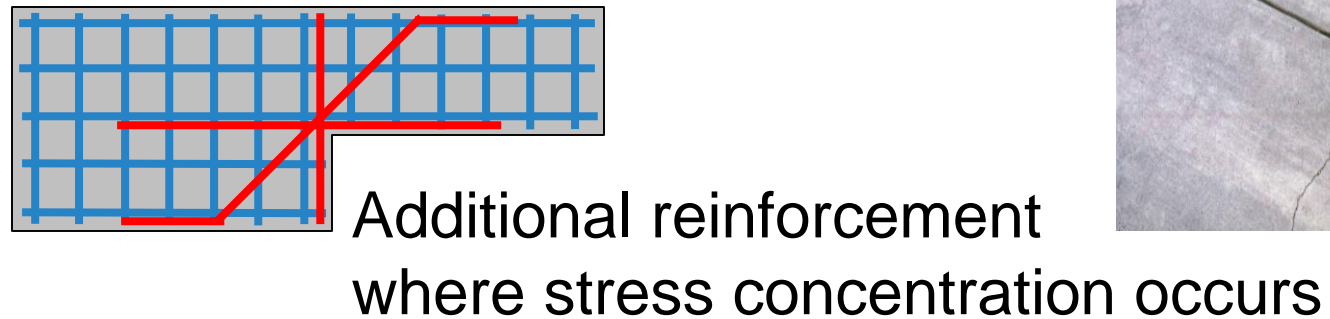
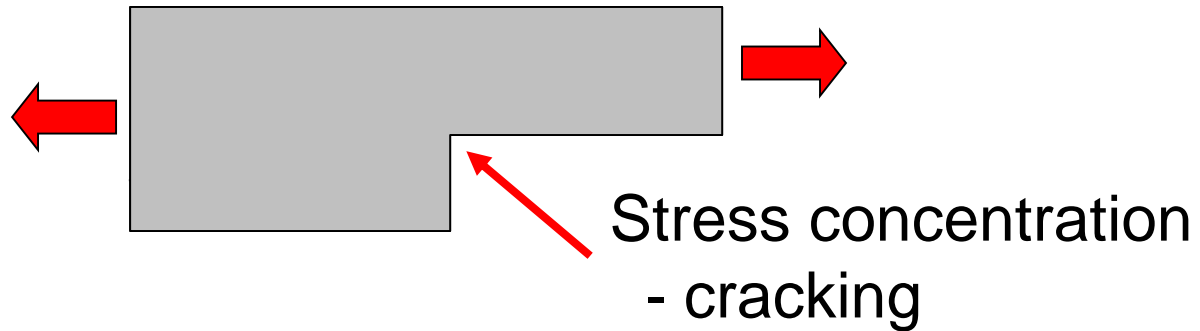
Placement of Reinforcement

Anywhere concrete might be in tension ► OPENINGS











Placement of Reinforcement

Anywhere concrete might be in tension ► **CHANGE IN SHAPE**



Reinforcing Steel Today



	A-615	Carbon Steel
	A-706	Weld Specification
	A-767	Galvanized
	A-775	Epoxy Coated
	A-934	Epoxy Coated
	A-1055	Zinc + Polymer Membrane
	A-955	Stainless
	A-1035	Low-Carbon-Chromium

High Strength Steel

Grade 60

vs.

Grade 80

vs.

Grade 100



Reinforcing Steel Specifications

Grade 60

- **A615 – Plain carbon steel**

 - ACI 318-19 Change Ultimate to 80 to match A706

 - Change T/Y to be 1.10 to insure ductility

- **A706 – Low alloy steel**



High Strength Reinforcing

Grade 80

- **ASTM A615**

- Only in non-seismic applications

- **ASTM A706**

- ACI 318-19 Allows for Special Moment Frames
- No Shear
- T/Y Ratio of 1.25



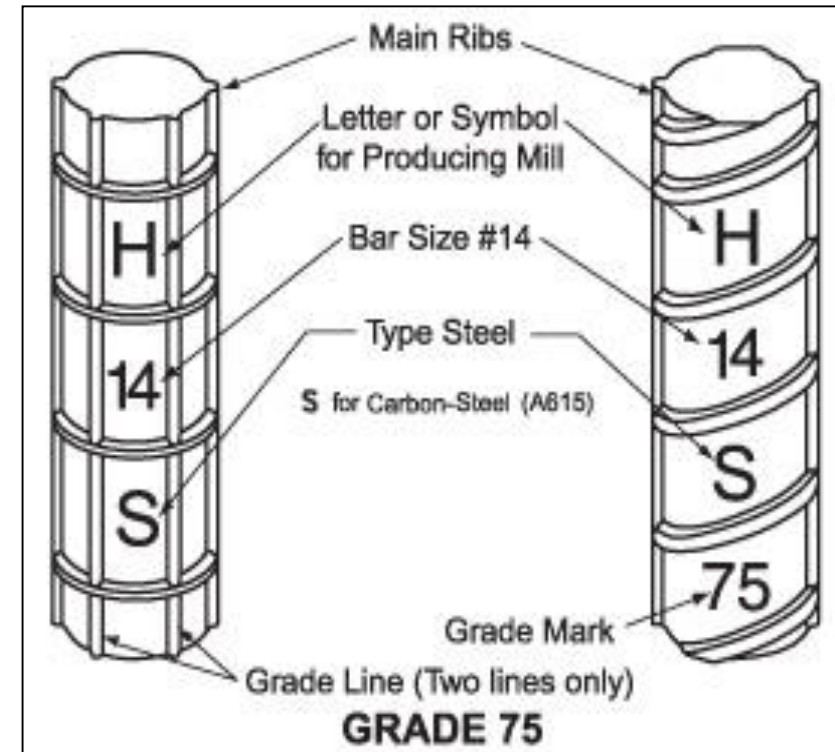
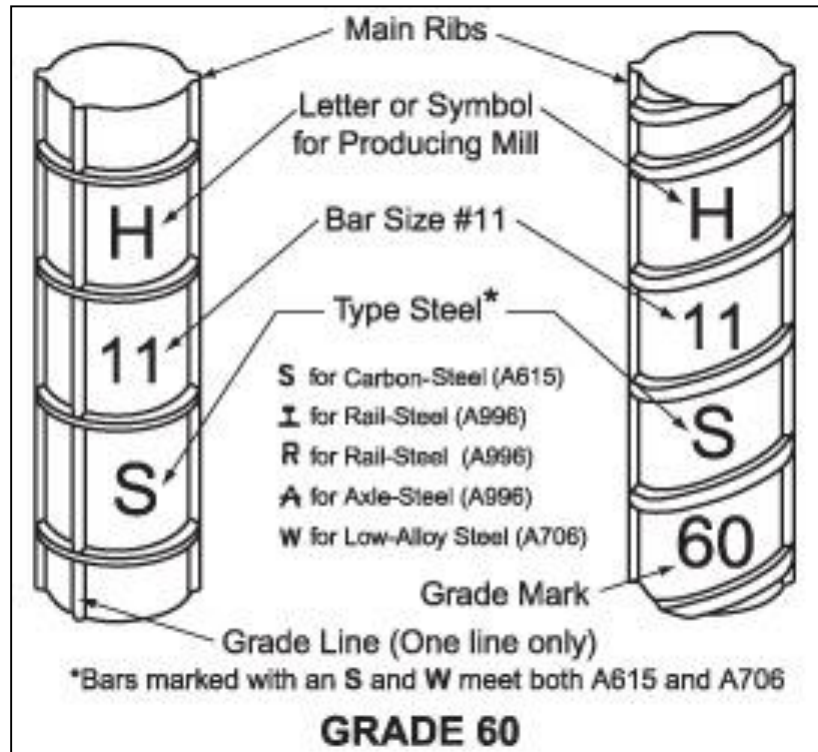
High Strength Reinforcing

Grade 100

- **ASTM A615 (2019)**
- **ASTM A706 (2019)**
 - ACI 318-19 will allow for seismic design
 - T/Y Ratio of 1.17
 - Gravity and Wind, Confinement, Special Str. Walls, Won't be weldable

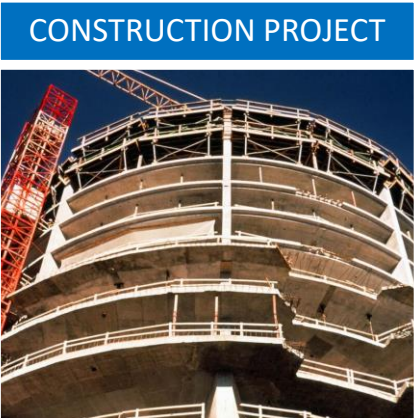
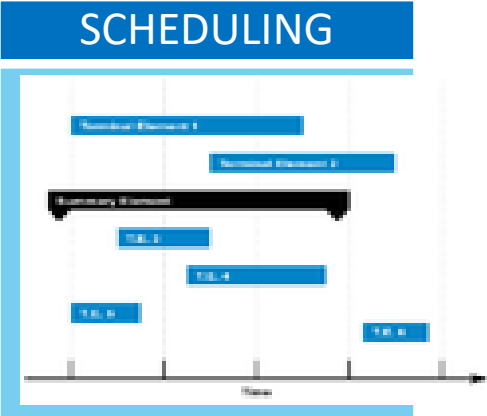


Reinforcing Bar Markings



- New radius vs height of deformation ratio of 1.5, ACI 318-19 adopted, ASTM working on.

Economics of Concrete Buildings



Economics of Concrete Buildings

Three elements of structure cost



Floor systems



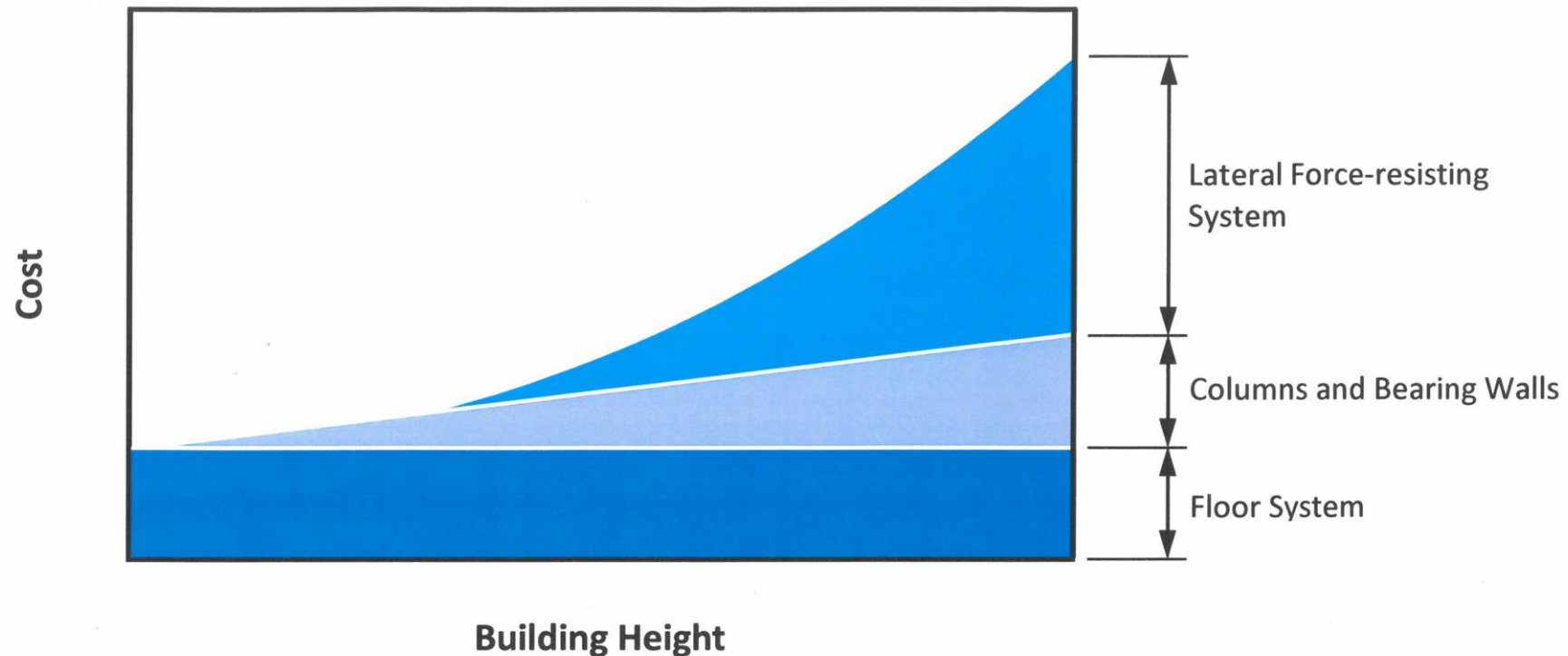
Columns and bearing walls



Lateral force-resisting systems

Economics of Concrete Buildings

Structure cost versus building height



Economics of Concrete Buildings

Main Component Costs



Formwork



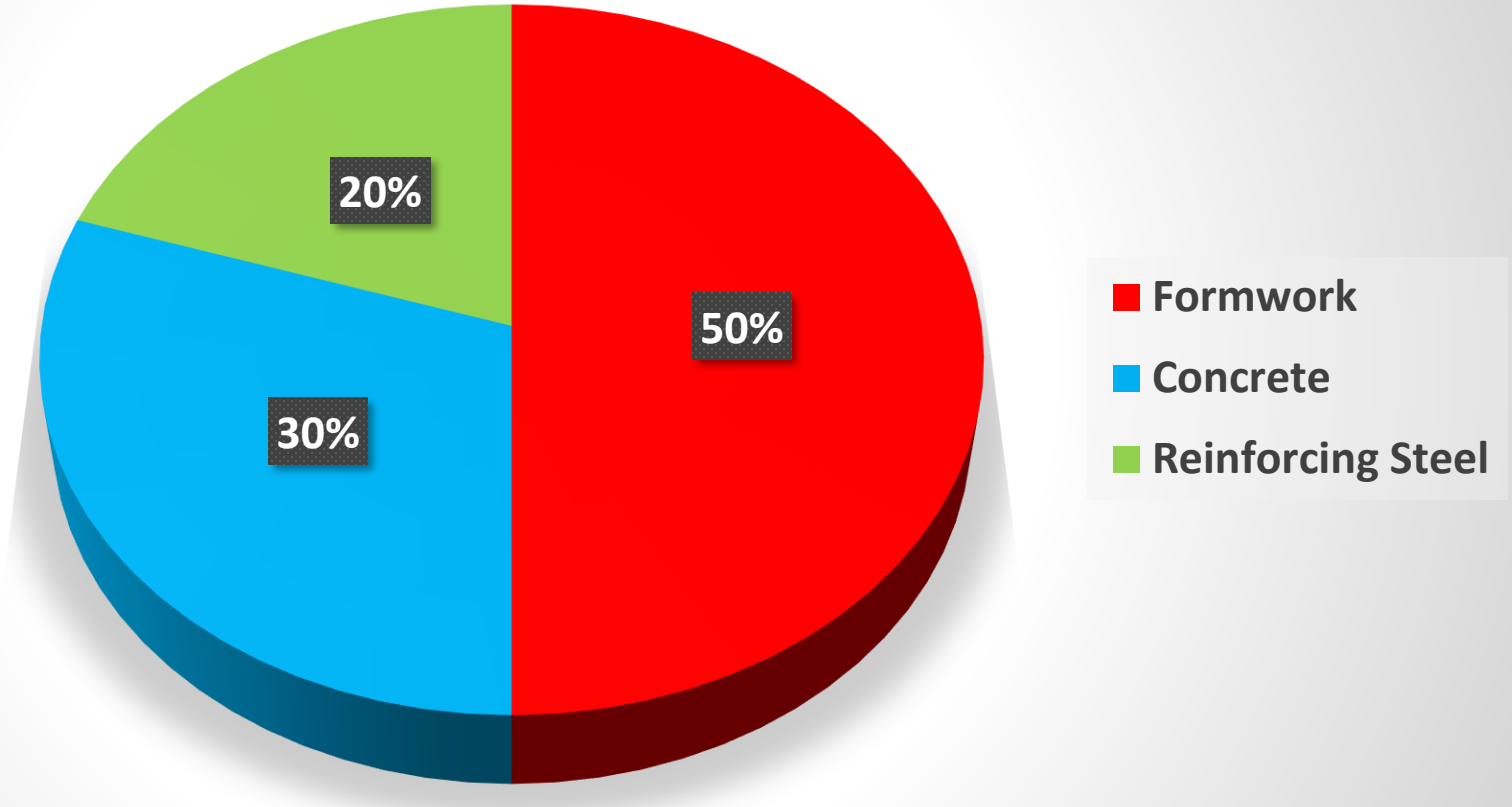
Concrete



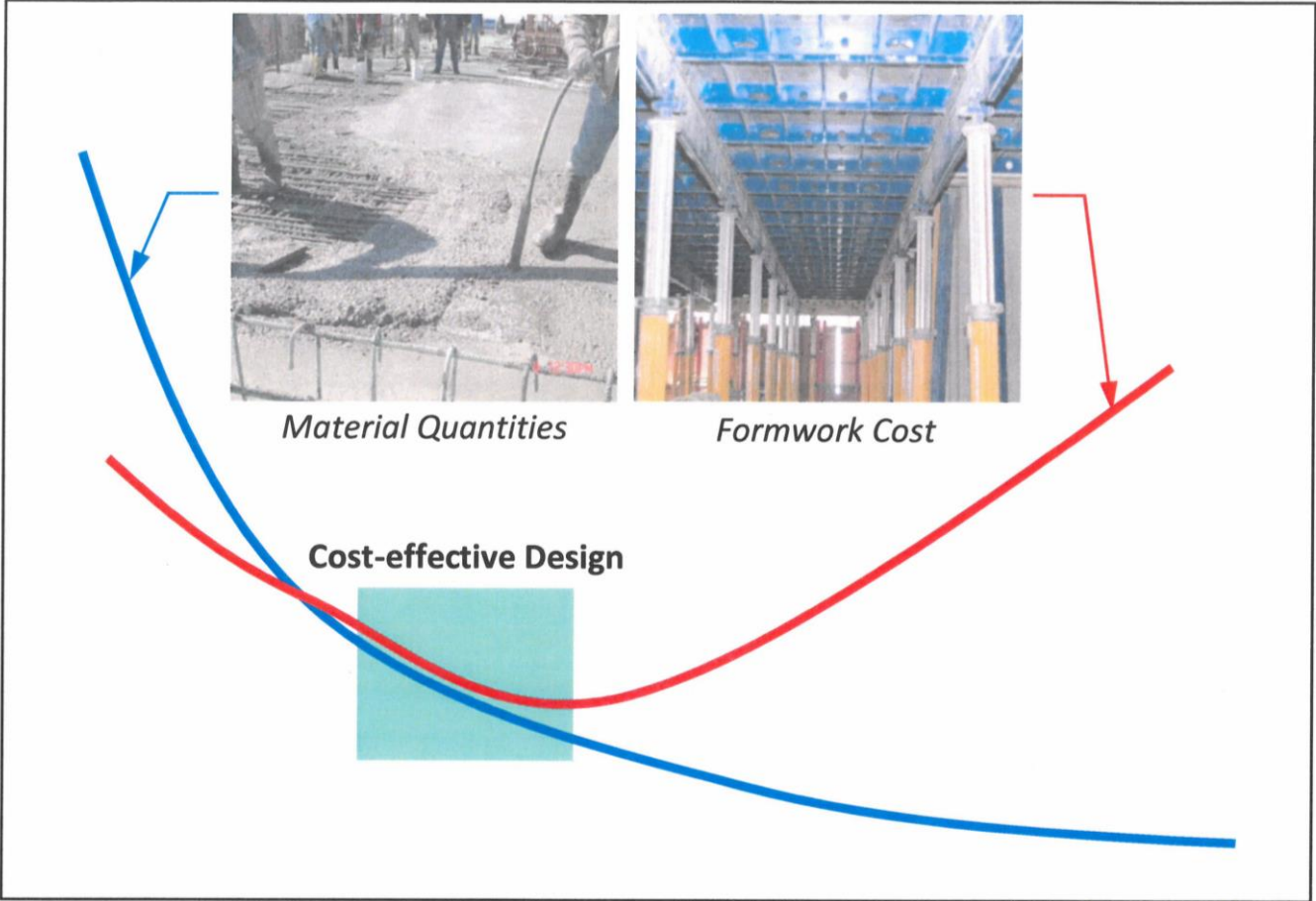
Reinforcing steel

Economics of Concrete Buildings

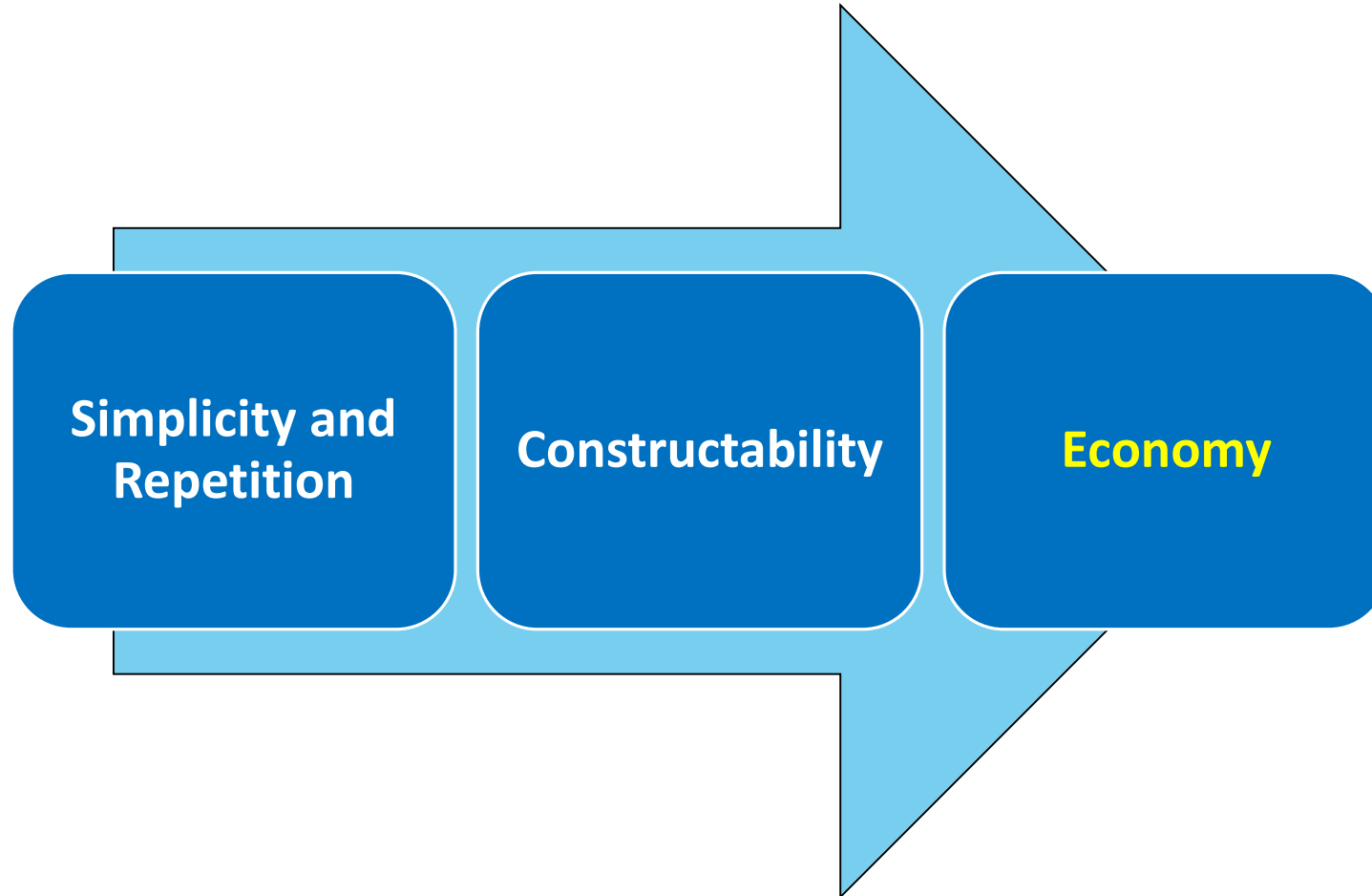
U.S. National Average of In-place Costs



Economics of Concrete Buildings



Economics of Concrete Buildings



Constructability



Placing



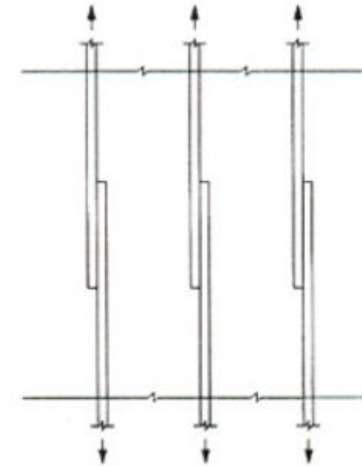
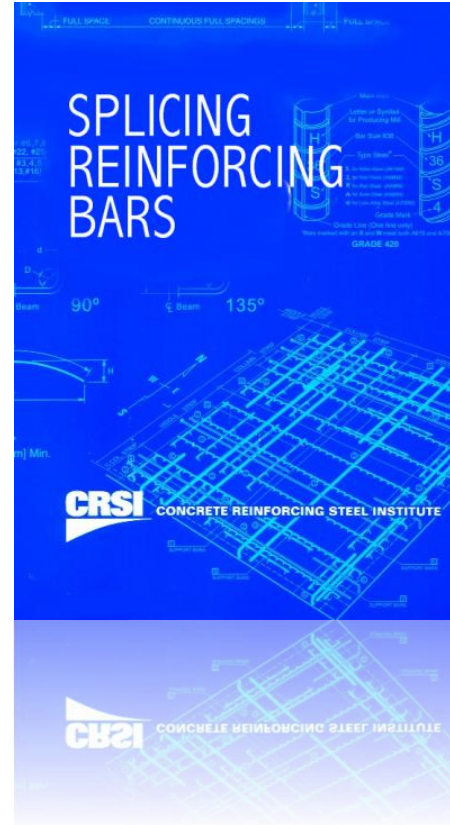
Splicing

Lap Splices

Welded Splices

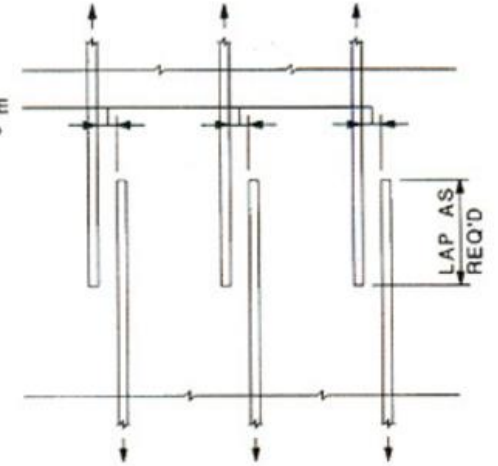
Mechanical Splices

- Deformation Dependent
- Non-Deformation Dependent



Contact Lap Splices
(Preferred)

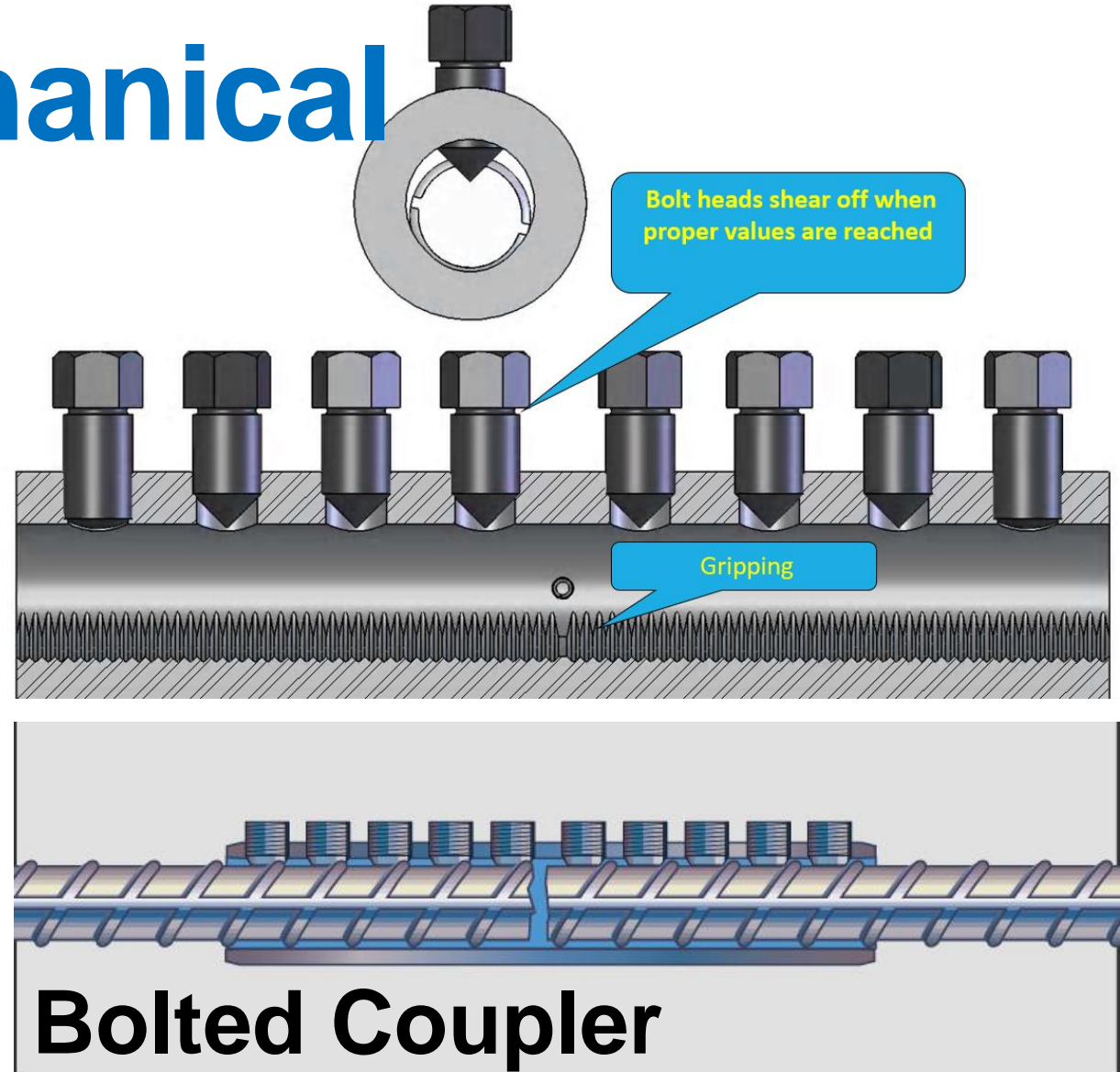
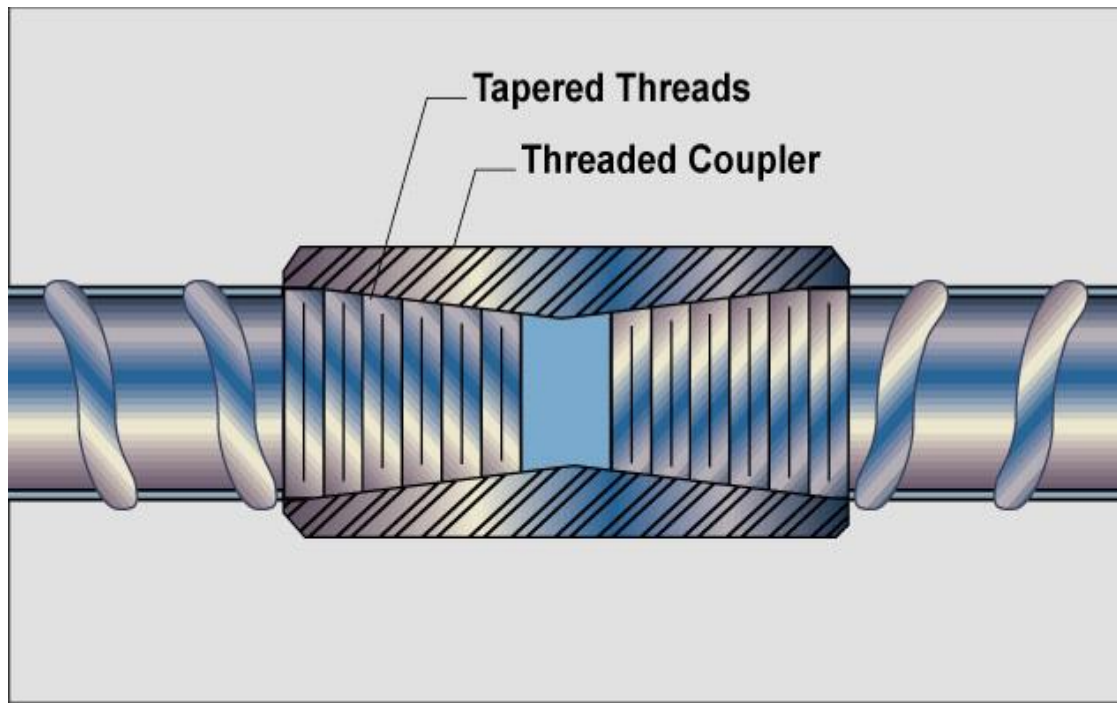
CLEAR SPACE
MAX. 1/5 LAP
LENGTH, BUT
NOT MORE
THAN 6 in.
(150 mm)



Non-Contact Lap Splices

Splicing - Mechanical

Threaded Coupler



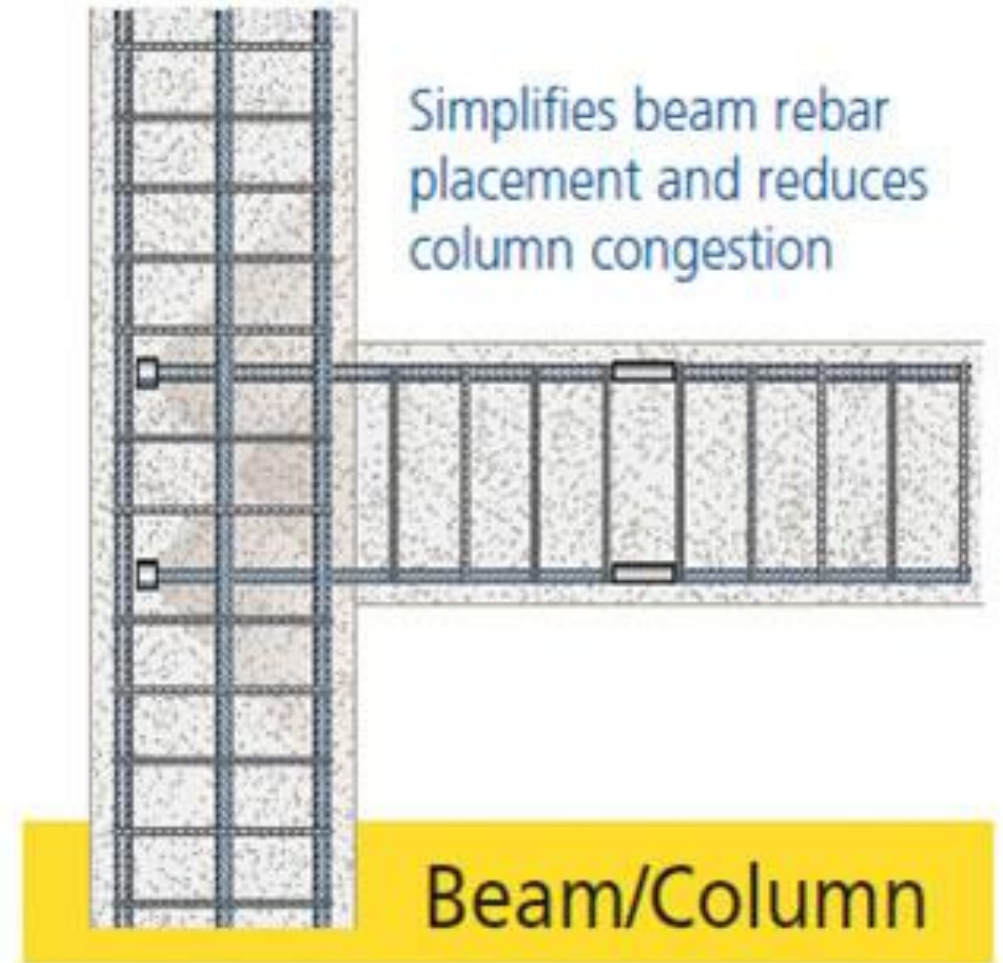
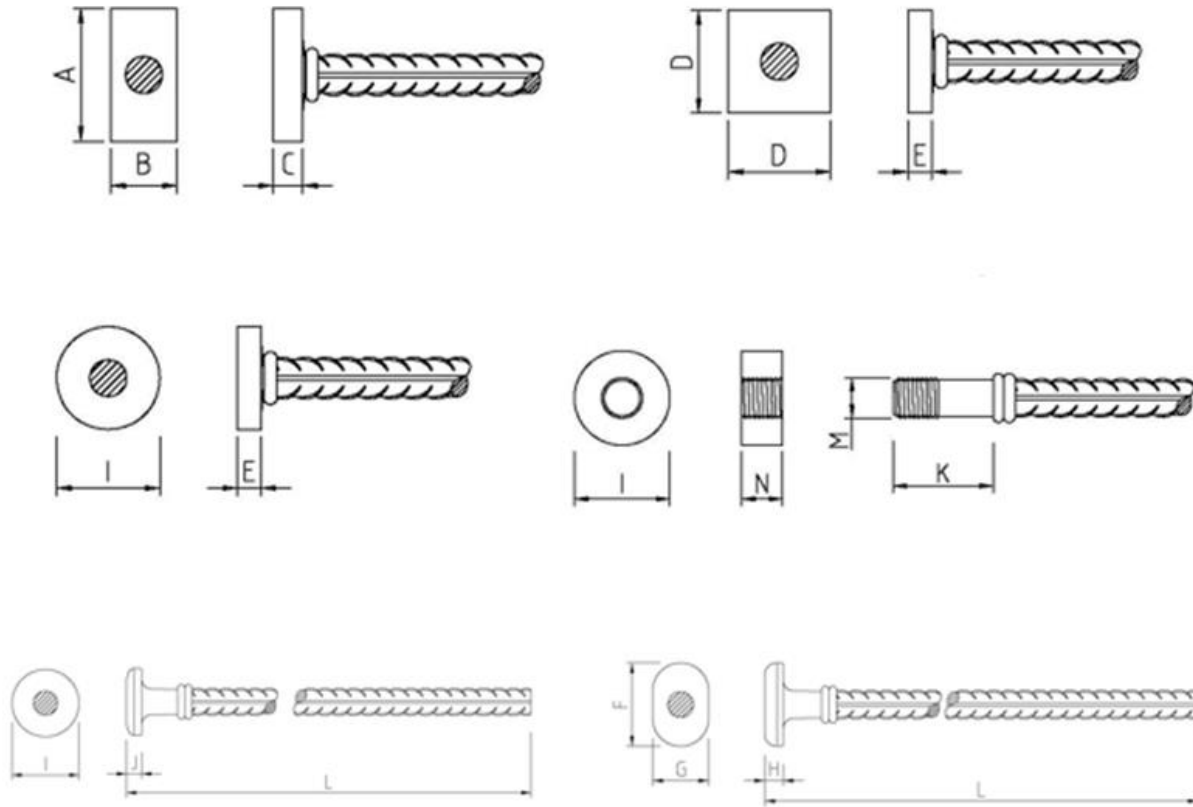
Anchorage

Headed Bars

- Reduce Congestion
- Come in Various Shapes
- Threaded or welded on



Anchorage



Economics of Concrete Buildings



Economics of Concrete Buildings

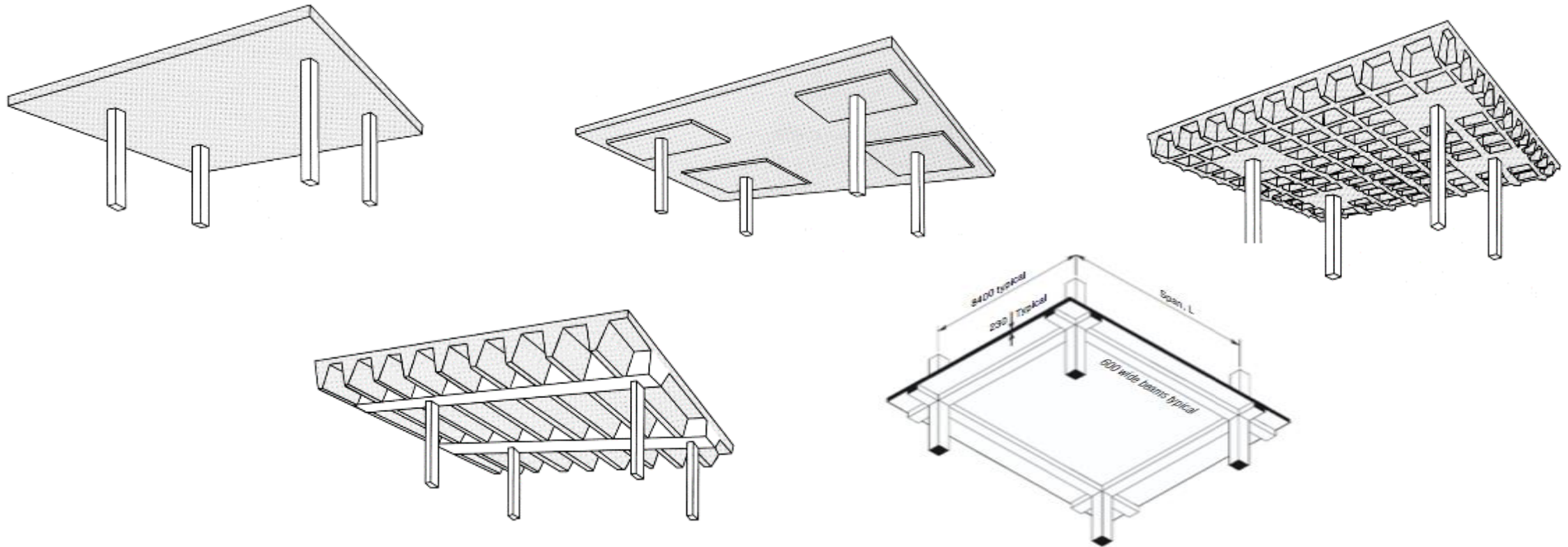
Span	Live Load (psf)	Floor System			
		Flat Plate	Flat Slab	Wide-module Joist	Two-way Joist
Up to 20 ft	40, 65, 100	X			
21 – 25 ft	40	X			
	65	X	X		
	100		X	X	
26 – 30 ft	40, 65, 100		X	X	
31 – 40 ft	40, 65, 100			X	X
41 – 50 ft	40, 65, 100				X

Innovative Concrete Forming/Framing Systems

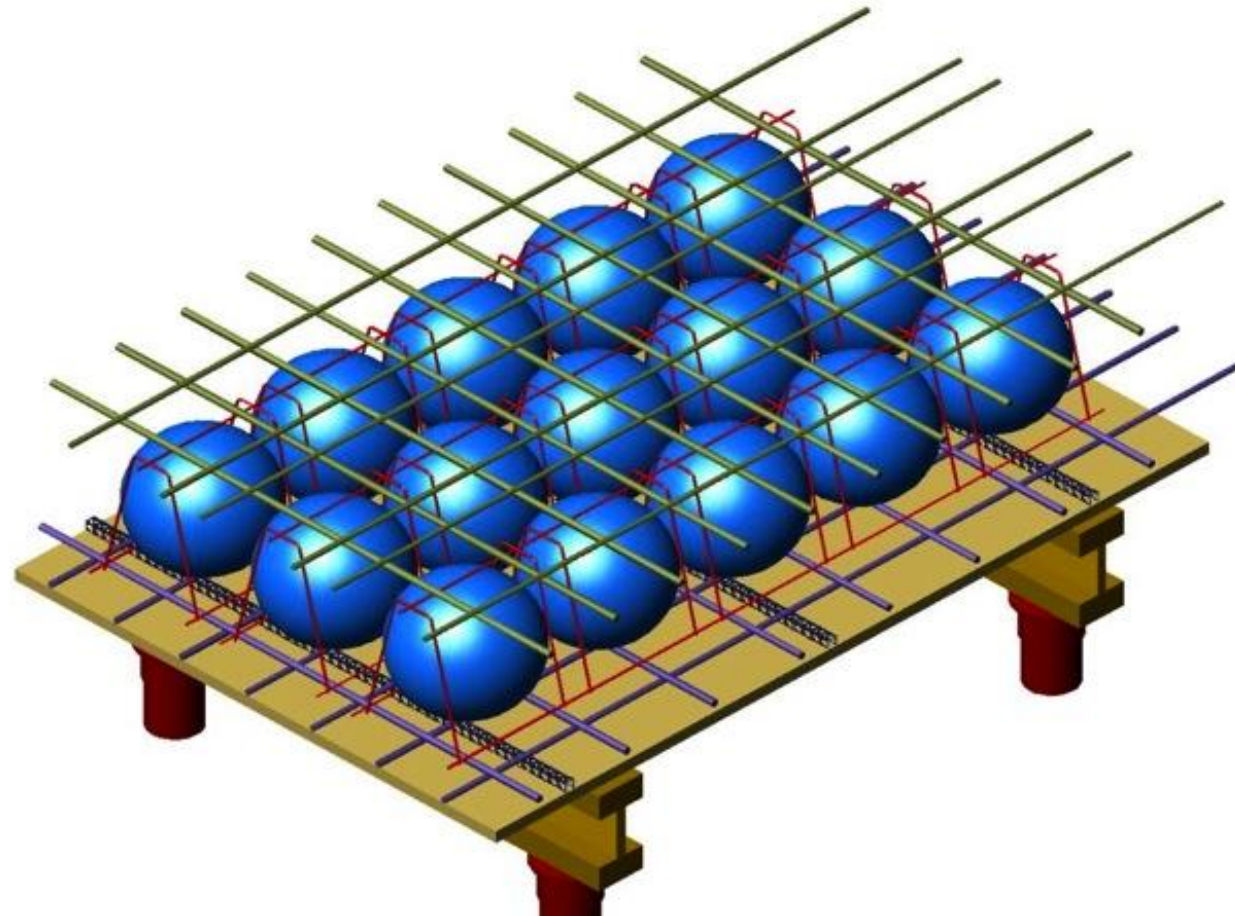
An Innovative forming system for every application

- 1. Traditional**
- 2. Voided Slab**
- 3. Tunnel Form**
- 4. Insulated Concrete Forms**

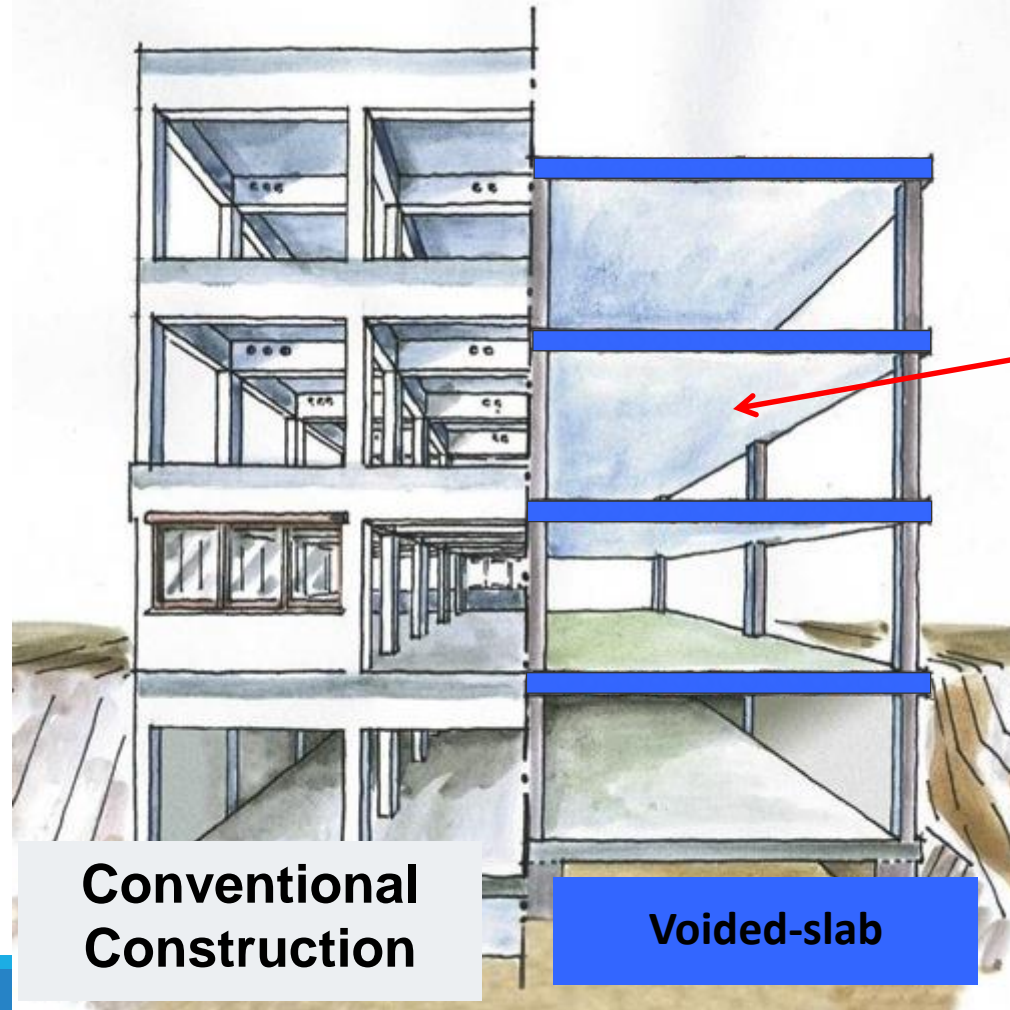
Traditional Formed Floor Systems



Voided Flat Plate – The Concept

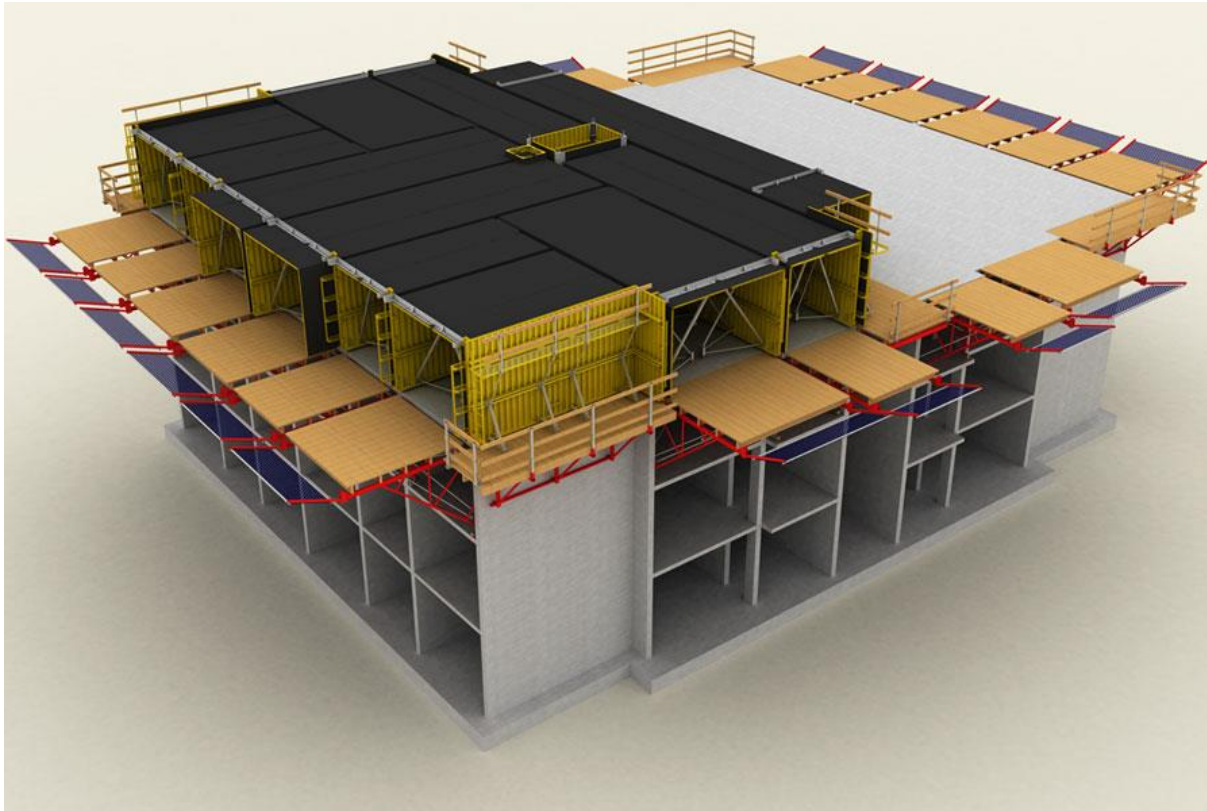


Voided Flat Plate - Benefits



Long Spans
Reduced Dead Load
No Beams
Lower Flr to Flr Height

Tunnel Form – Low Rise to High Rise Floor and Wall System



- 1. Fast and Economical**
- 2. Superior Acoustic Performance**
- 3. Energy Efficient**
- 4. Easy finishing**
- 5. Popular in Texas and Florida**
- 6. Competes with 2 way PT Flat Slab**

Insulated Concrete Formwork (ICF)



Good for low to mid-rise construction

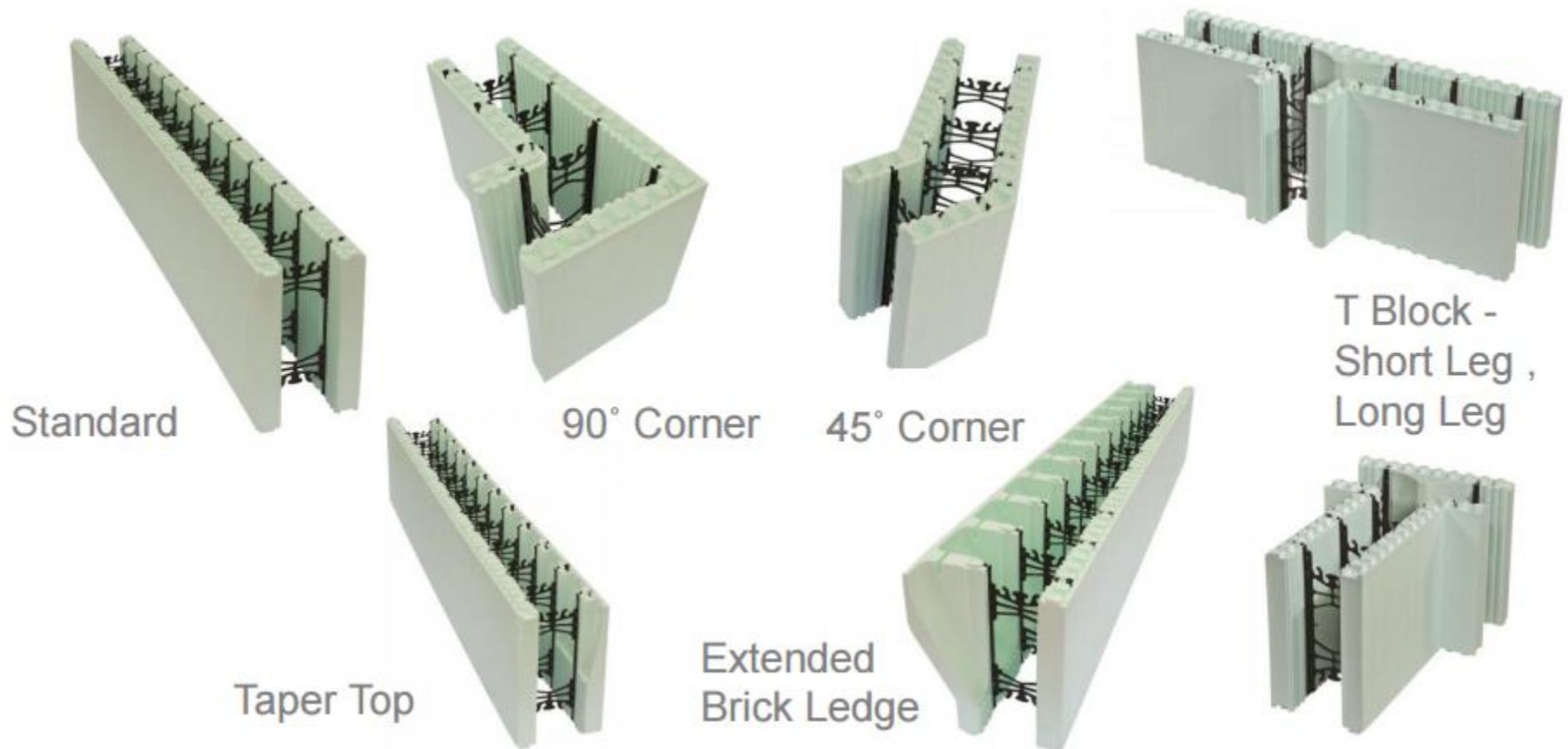
6 components in 1-system:

- Concrete**
- Reinforcement**
- Insulation**
- Air Barrier**
- Vapor Barrier**
- Studs/Strapping**

ICF Benefits

- 1. Fast and Economical**
- 2. Superior Acoustic Performance – 6” core STC 50, with Gyp STC 71**
- 3. Energy Efficient**
- 4. Easy finishing**
- 5. Competes with Wood and Cold Formed, but more resilient**
- 6. Faster than Block & Plank**
- 7. Can be used as exterior wall only or with interior non-structural**
- 8. Resists 250 mph tornado/hurricanes**

ICF Components



Innovations - HoleDeck



Innovations - ICF



Good for low to mid-rise construction
6 components in 1-system:

Concrete
Reinforcement
Insulation
Air Barrier
Vapor Barrier
Studs/Strapping

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Reinforcing Basics



Concrete Benefits



Education and Tools



Design Resources



Construction Resources

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