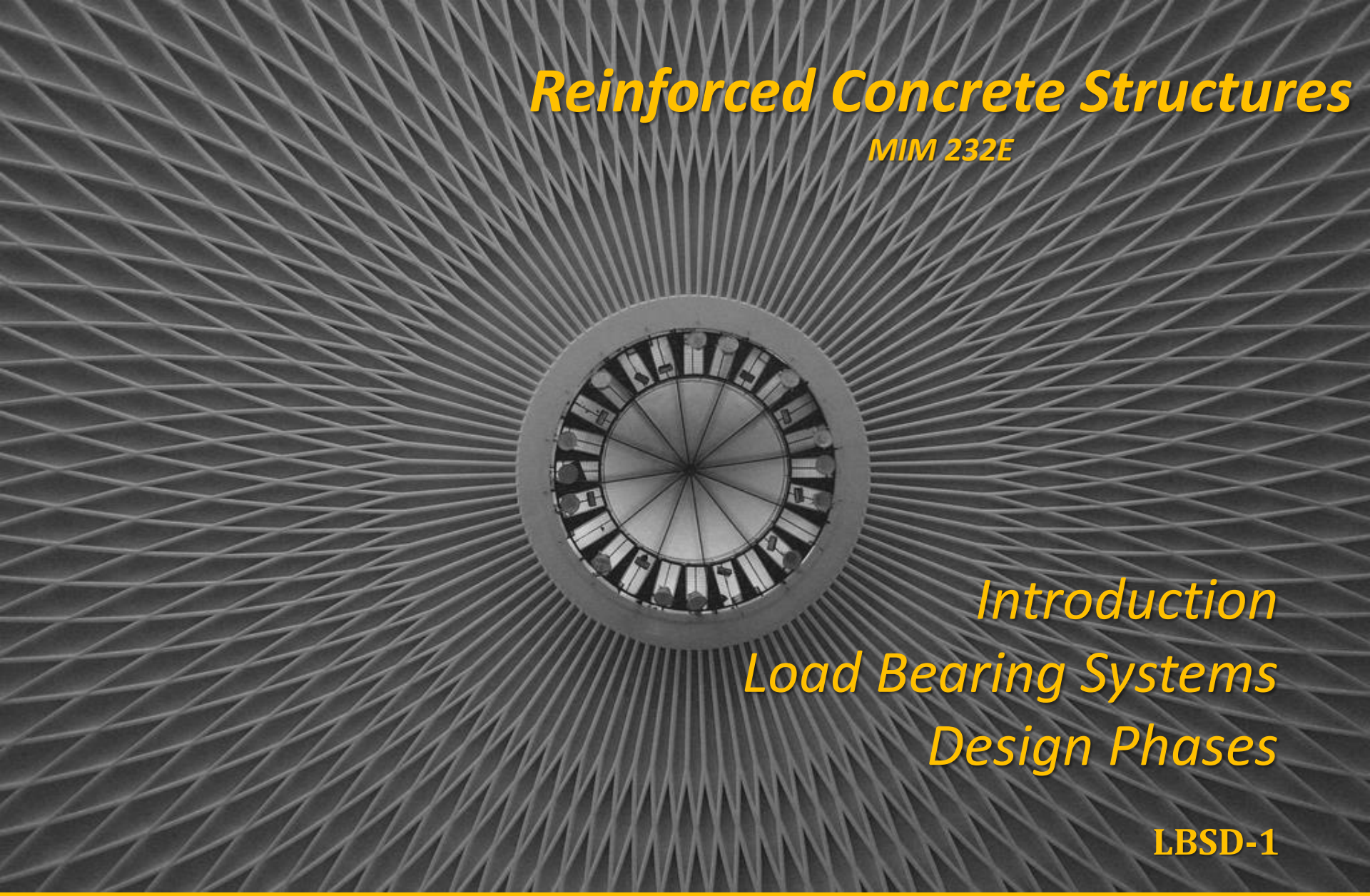


# Reinforced Concrete Structures

**MIM 232E**

## Introduction
## Load Bearing Systems
## Design Phases

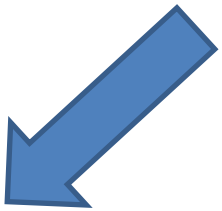
**LBSD-1**

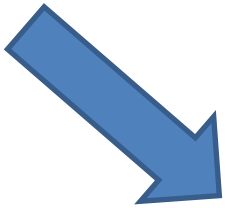
**Dr. Haluk Sesigür**
I.T.U. Faculty of Architecture
Structural and Earthquake Engineering WG

# Introduction

## Course teaching

***Reinforced Concrete Structures***



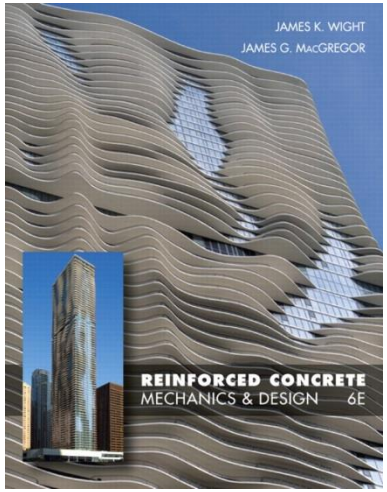


Load-Bearing System Design (LBSD)
*Friday*

Reinforced Concrete Structure Design (RCSD)
*Tuesday*

| Assessment Criteria | Activities | Quantity | Effects on Grading % |
|---|---|---|---|
| | **Midterm Exam LBSD** | 1 | 20 |
| | **Midterm Exam RCSD** | 1 | 20 |
| | **Final Exam** | 1 | 60 |

## References

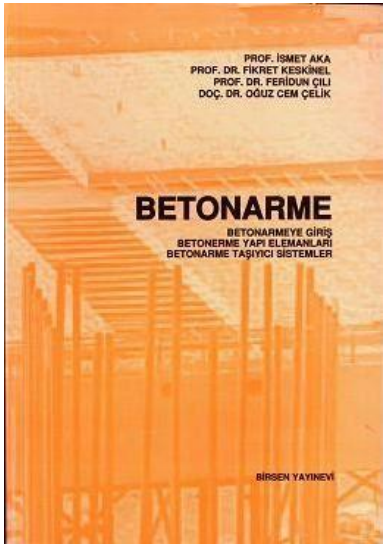



**Reinforced Concrete: Mechanics and Design (6e)**
J.K.Wight, J.G. MacGregor

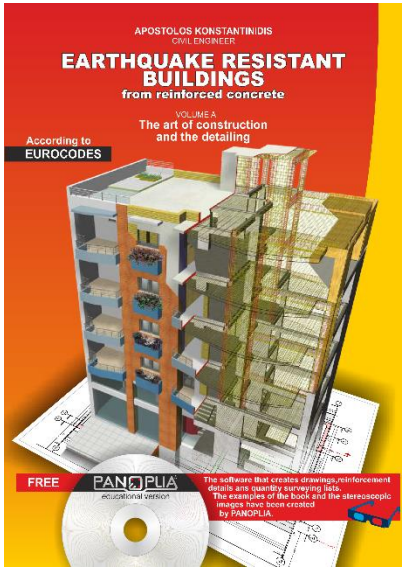
Pearson Higher Ed USA, 2011.

**Betonarme**
İ. Aka – F. Keskinel – F. Çılı – O.C. Çelik

Birsen Yayınevi (Pub.), 2001



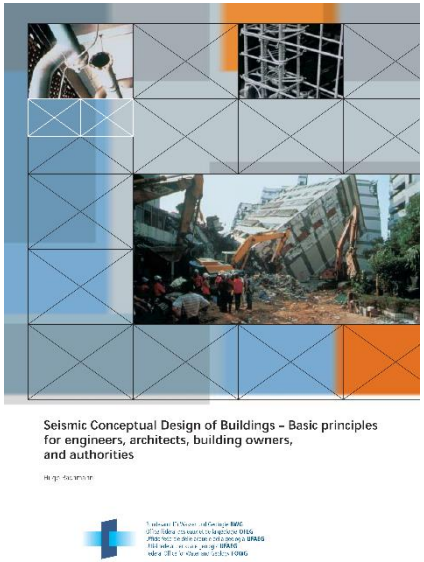
## References




**Earthquake Resistant Buildings from RC**

A.Konstantinidis

2010




**Seismic Conceptual Design of Buildings- Basic Principles for engineers, architects, building owners**

H.Bachmann

2003

## Course Content

| | RC_RCSD |
|---|---|
| | Intro, Properties of RC, Related building codes |
| | Ultimate Strength Theory, Pure Bending |
| | Problem Solving |
| | Comb. Bending of Beams, Cross-Sections with Double Reinforcement |
| | T Section Beams, Columns, Interaction Diagrams |
| | Problem Solving |
| | Shear Effect in Beams |
| | Problem Solving |
| | One-Way Slabs |
| | Problem Solving |
| | Two-Way Slabs |
| | Problem Solving |

## Course Content

| | RC_LBSD |
|---|---|
| | Introduction |
| | Load Bearing System, Design Phases |
| | Loads, LBS Arrangement Principles |
| | RC Slabs |
| | Structural/Seismic Joints |
| | Tall Buildings, Horizontal Load Effect |
| | Roofing, Precast Systems, Purlins |
| | Frames, Cantilevers, Archs |
| | Shell LBS |
| | Foundations |
| | Principles of Turkish Seismic Code 2007 |
| | Earthquake Resistant Building Design |

## Reinforced Concrete (RC)

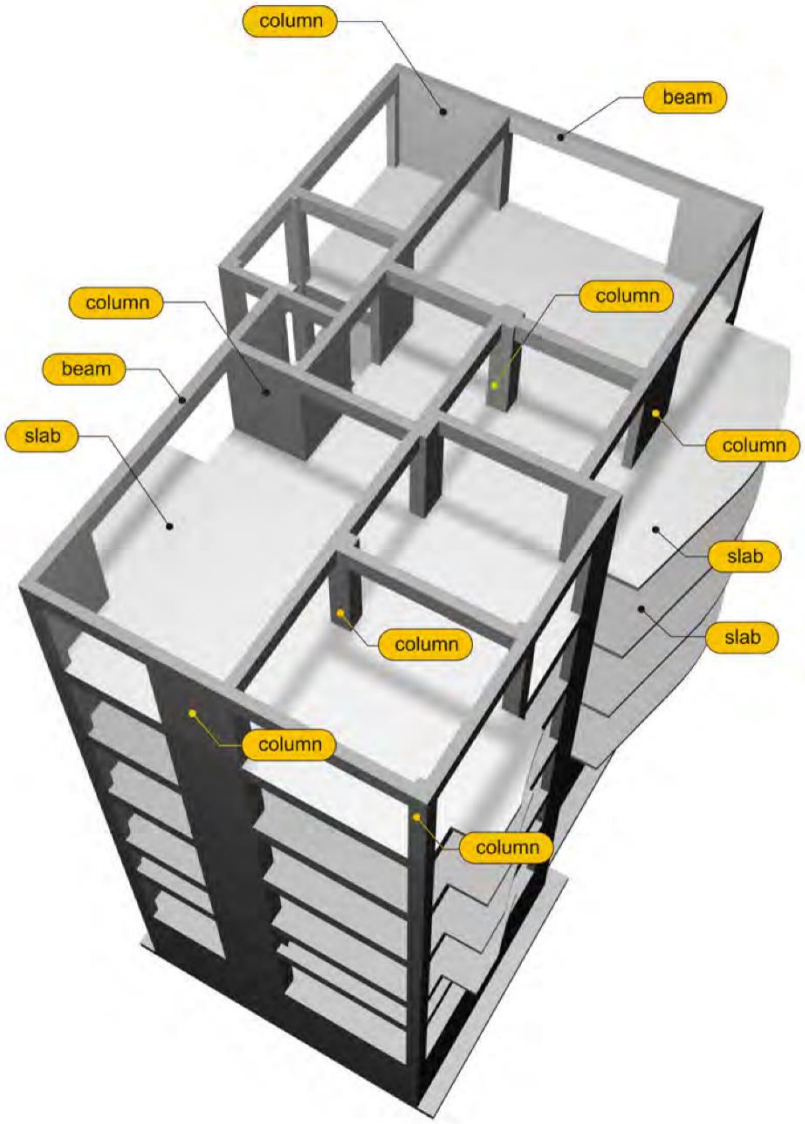
. The structural frame might not be visible externally in the final stage of the construction but it exists internally and it constantly supports the structure.

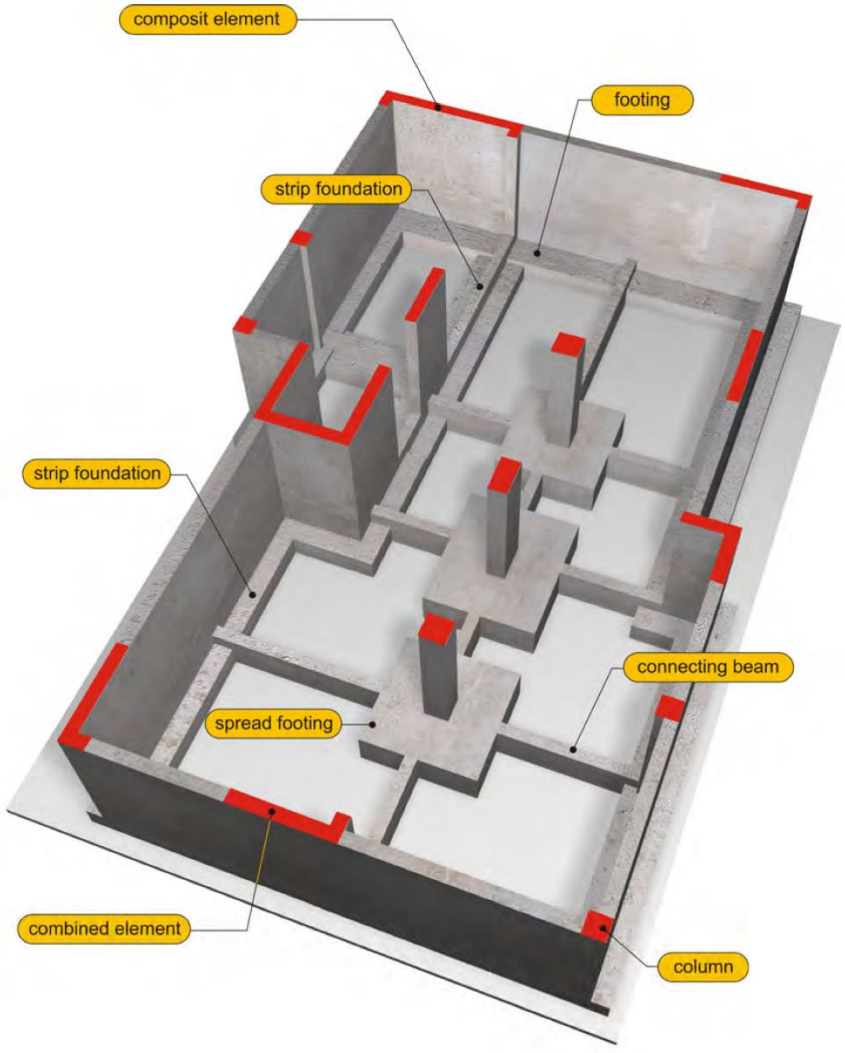
The structural frame is composed of horizontal and vertical load bearing elements as well as of foundation elements.

Every structure consists of the load bearing system which is usually constructed by reinforced concrete, steel or by a combination of those two materials.

# Introduction

## Reinforced Concrete (RC)

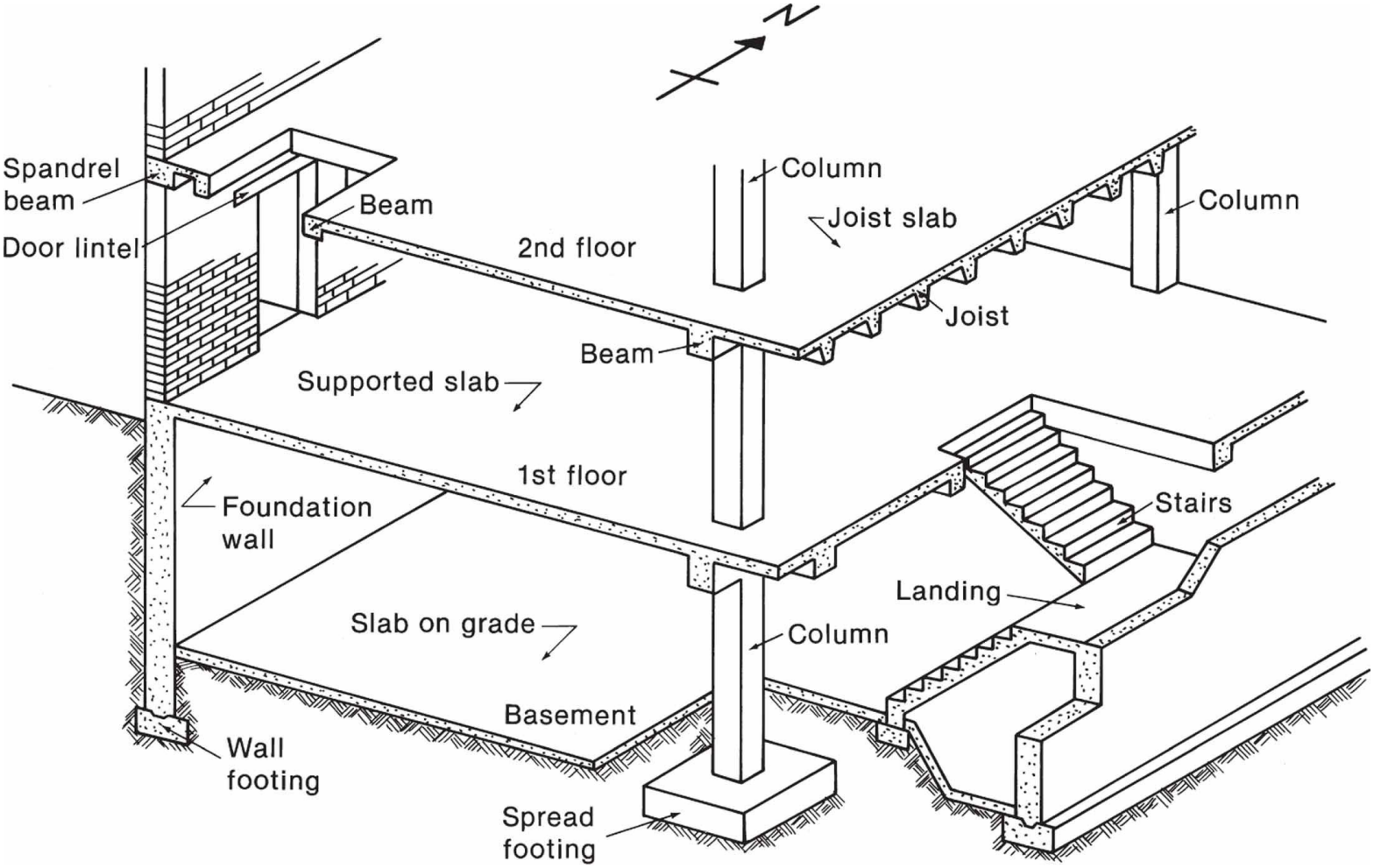



*Structure's foundation*

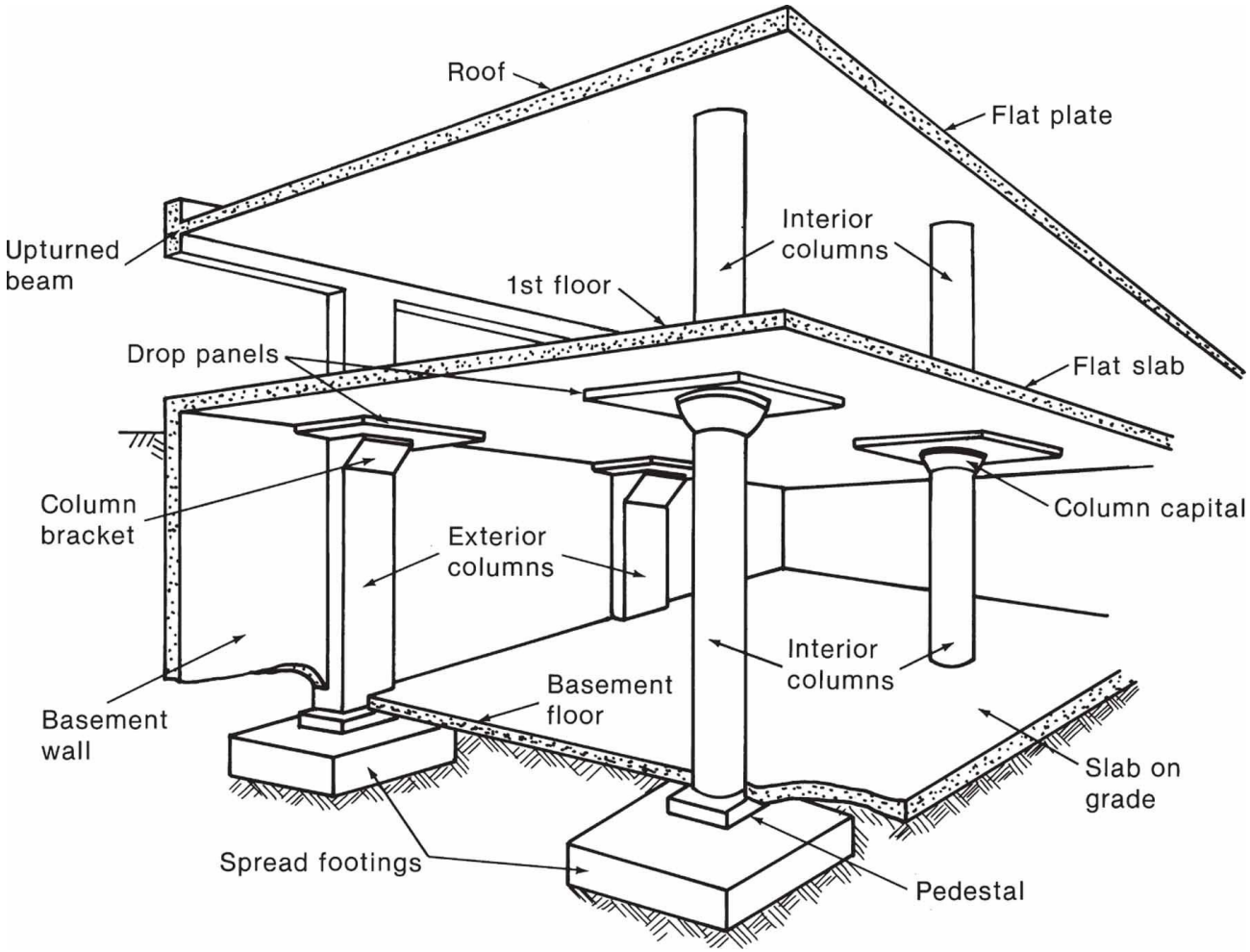
# Introduction

## Reinforced Concrete (RC)



# Introduction

## Reinforced Concrete (RC)



# Introduction



- *Begin 1850's...*
- *One of the most important/used structural material so far*
- *Concrete + Steel (reinforcement) = Reinforced concrete (RC)*

pearson

- Cement as a binder material; 18th Cent.
  - Today' cement; Aspdin, 19.yy, Portland Cement
  - First factory; 1848, Kent/UK

- Reinforced Concrete; the first patent; 1855 Coignet, 1857 Monier
  - 1855, RC vessel, Lambot
  - 1872, RC water storage, Monier
  - 1882, RC drainage tunnel coating, Coignet
  - Coignet; pionner for RC and its computations
  - 1892, Stanford univ./Museum
  - The first code 1905, DIN

# Introduction

## *Reinforced Concrete (RC)*

- Ingalls Building - the first reinforced concrete high rise building ever constructed, 1902-1903, Cincinati, Ohio,USA

Ingals Building. Cincinnati, Ohio



http://www.concretecontractor.com/concrete-construction-projects/ingalls-building/

# Introduction

## Reinforced Concrete (RC)

# Introduction

## *Reinforced Concrete (RC)*

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## *Reinforced Concrete (RC)*

# Introduction

## *Reinforced Concrete (RC)*

## Inroduction

- Basic function of a bldg;

  - Supply sheltering & working space
  - Transfer loads, acting on it, to the soil

- Structure:

  LBS members + members required for sheltering & working

- Good design of a structure / building is an art.

## Inroduction

- Structural Safety → Civil Engineer (LBSD)
- Civil Eng. → Safety + Aesthetics (Arch.)
- Purpose:

In the begining of design; arrangement of a good/proper LBS

## Inroduction

- Basic function of a LBS;

  - Carrying loads (acting on it + self-weight), transfer the loads to soil safely in the shortest way.
  - Supplying stability of the structure

- Carrying: Under several loading condition, providing sufficient safety without cracking, with limited deformation.

## Inroduction

- Structure;
  construct as safe and with min. material/workmanship as possible.

- Project → Architect + Related Engineers

- For a good project/design;
  - All specialists should work together, from the begining

- Project → Architecture + LBSD (CE), Mechanical, Electricity, Installation, Interior Arch. Etc.

- A good teamwork is required...

## Inroduction

- LBS Design, after other works proceeded/completed,is not proper.
- All interdisciplinary design steps should be executed together (collobration); each is an important part of design.
- Approach the problems in a comprehensive manner in design steps
- Eng. & Arch.;

Fullfil a LBSD compatible with science and technique.

## Inroduction

- Eng. is not only calculation
- LBSD;
  eng. insight, experience etc.
- Calculation results should be checked and interpreted in the correct way, for good engineering
- Knowladge on structural material & material properties and accurate usage of materials

.....required

## Design Phases

- Several design steps, with growing scale

- In each step,
  the part of LBSD are explained as following;

1 – Initial idea project (Scale:1/500)

- Determine plan, volume, geometry and LBS type that effects aesthetics.

- Investigate LBS types, material, loads, EQ effects, structural joint location etc. and prepare a Report.

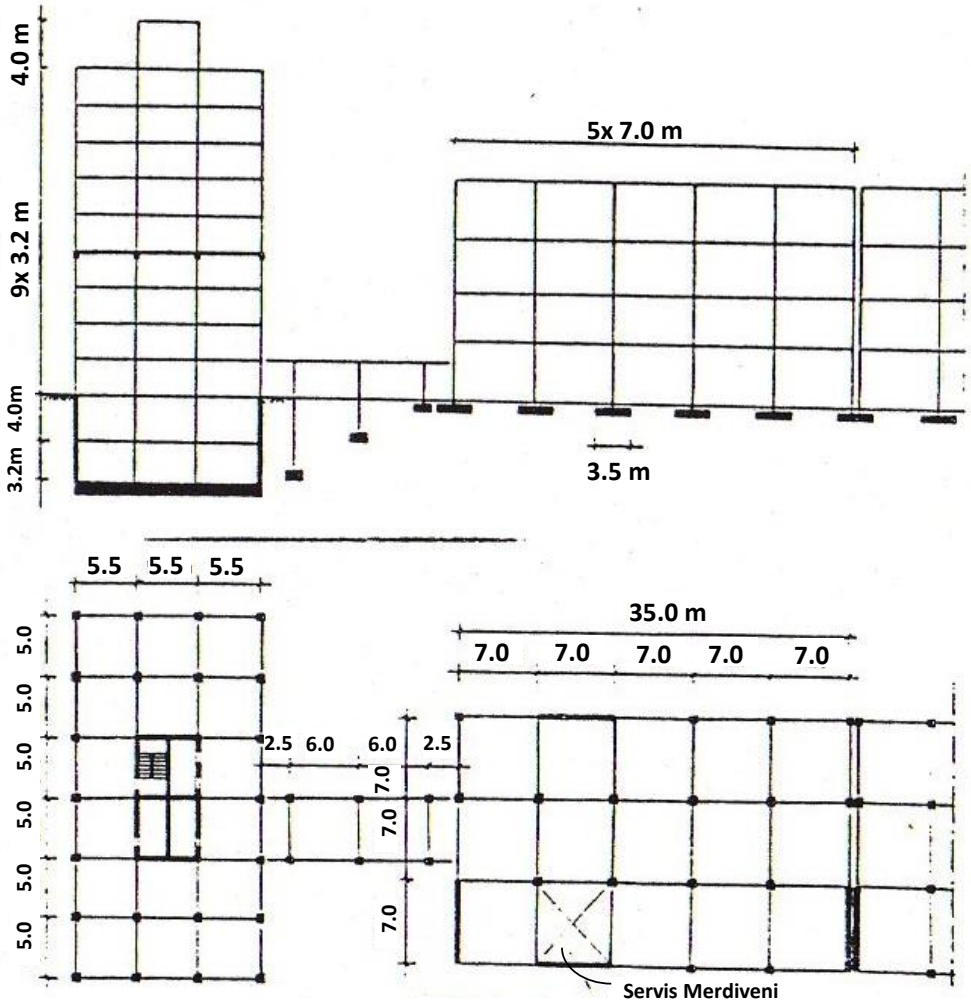
## Design Phases

2 – Preliminary project (Concept Design) (S: 1/200)

- Prepare arch. and LBS reports
  - Report includes, LBS material, bldg axis, structural joints, slabs types, foundation, installation relationships, cost analysis/comparison.

- Prepare Arch./structural system detail where needed

Sketch Ex.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2.5 6.0 6.0 2.5
7.0
7.0
7.0
Servis Merdiveni

3 – Final Project (S: 1/100)

- Architectural Project:
  - Based on Preliminary project , architecture, LBS, installation are developed due to investigations; Finally it becomes precise.

- LBS gets final/precise form in this step (calculation, dimensioning etc.)

4- Application project (1/50 - 1/20)

- As a result of initial collobration,
  LBS app. project is prepared by
  Civil/Structural Eng.

- If problems are not solved in steps 3-4,

  Construction period extends

## Design Phases

- Firstly, drawing formwork plan with approx. dimensions → Determines behavior, Idealazation of analysis model

- For healty application of the project;

  The project should be well-designed
  It should not have problem on site

- The first and most important step → LBSD

## Design Phases

- Civil eng.; individual work on this step
- Unexpected effects such as temperature, creep, buckling, foundation problems should be carefully investigated.

## Design Phases

- Project/design sheets and reports include;
    - Min. dimensions
    - Min., max. reinforcement ratio
    - Deflection checks
    - Crack control
    - Buckling safety control
    - Anchorage/interlocking
    - Concrete cover distance
    - Structural/seismic joints
    - Reinforcement quantity, length, spacing etc.

5- Design Program:

A summary of design phases:

Design:

Determination several possible solutions for a problem, investigation and freely selection of the most proper solution.

## Design Phases

- Good designer finds the best remedy among options (form, material, tech. etc)
- Every LBSD begins with a sketch and then it structurally checked.
- Strength and stabiliy must be valid along lifetime of a structure

## Design Phases

- To design a longlife/resistant structures;
  - Determine all loads (self-weight, live, EQ, wind etc.)
  - Determine internal forces for sections for the most unfavorable conditions
  - Restrict deformations
  - Obtain a good knowladge on material, do not exceed design strength/ultimate strength values
  - Finally, determine and assign member dimensions

## Formwork Plan (s:1/50)

- Below 1m from floor level, cut the storey horizontally, look upward and draw
- Generally, a plan belongs a storey or elevation
- Axes represented by:
  letters along short direction
  numbers along long direction
- Axis interval is given

# Load Bearing System

## Formwork Plan (s:1/50)

Beam → (K314) 25/50

Column → (S417) 40/60

Shear Wall → (P713) 20/300

Slab → (D325) h=15cm

Ribbed slab → N101 10/30

## Formwork Plan (s:1/50)

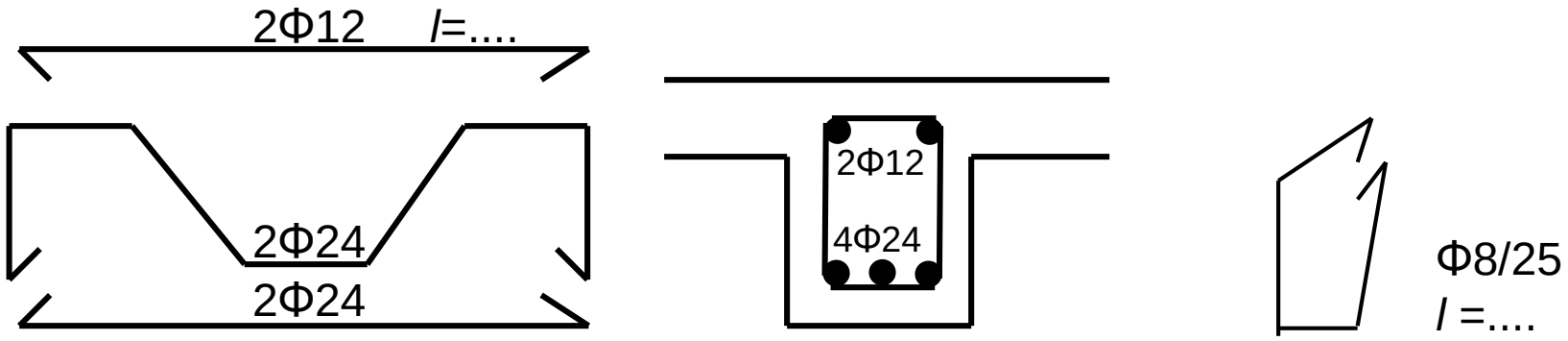
- Vertical cross-sections
- Staircase etc., on detail sheet
- Installation details/measurements
- Material quality (i.e. C25 , S420 )

## Reinforcement Plan

- Prepared as a seperate sheet

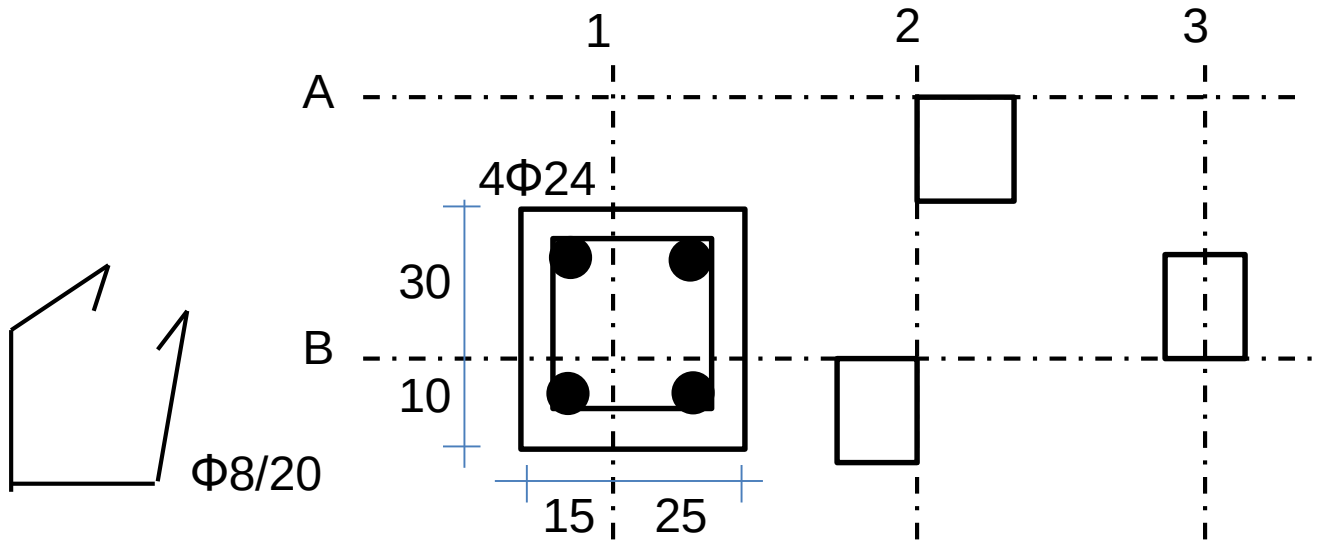
  diameter/spacing and total lengths are given.
  φ8 / 35  l = 715

- Beam reinforcements; (S:1/20)



## Reinforcement Plan

- Column Application plan:
  On 1/50 or 1/100 scale axis plan,
  Drawing columns by s:1/20 with reinforcement
  Drawing due to long/short edges



## Foundation Plan

Single/pad foundation

continuous footing → like beam
Raft/mat → like slab