System Design Fundamentals

Abdul Razzaq Touqan

Civil Engineering

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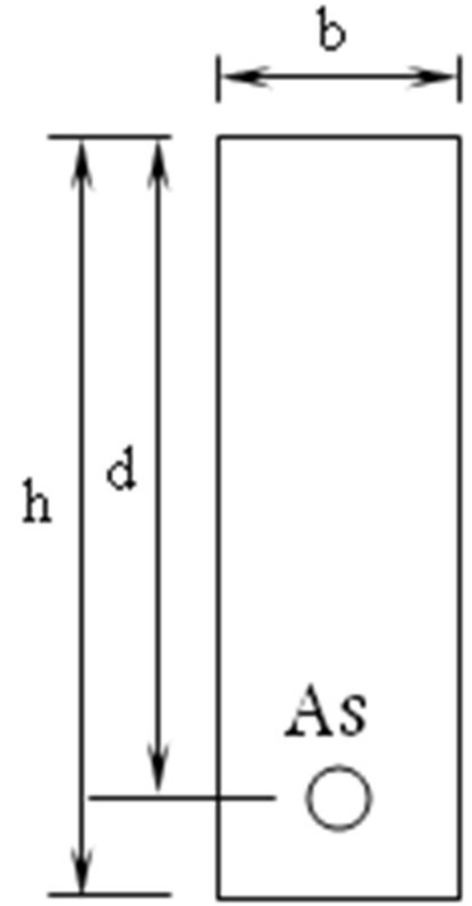
Objectives:

-to introduce the building construction determinant

-to analyze different systems by finite element method and analogical methods

-to build conceptual abilities in designing reinforced concrete elements.



Preface

- Most of the education and research is concentrated in analytical and anatomical skills and very little in creativity skills (analogical skills) which is fundamental in design.

- Creativity is the ability to conceive, generate design alternatives and preserve environment. It requires compositional ability.

- Compositional ability requires conceptual understanding which is based on both: “a feeling” for behavior and “approximate” analysis\design skills

Preface

- System design addresses the need for conceptual design skills.

- A design project provides opportunity for teams of students to create conceptual designs and make representations to a design “jury”.

- It provides opportunity to concentrate on the structure as a whole and very little on the element behavior.

- The conceptual design is based on a systematical approach

Chapter 1 Introduction

- Introduction to systems
- Purpose
- System determinants
- Standards versus codes
- Fundamentals of thinking

Introduction to systems:

- A system can be defined as a group of related parts that move or work together.

- A system is a necessary part of life. It occurs at any level, ranging from the molecular structure of material to laws of universe.

- As **order**, it relates all the parts of a whole reflecting some pattern of **organization**.

- Everything has system, even if we have not yet recognized it. Societies are a form of structural systems to properly function- language has system, the interrelationship of plants and animals with their **environment** represents equilibrium in nature which is a system by itself.

- Golden number, frequency 528

Purpose

- The purpose of a system is to combine global understanding with local details.
  - Discuss face of human being and how systematically it combines architectural, structural, mechanical and electrical systems
  - Analogy between a mosque and shape of human raising his hands.

System determinants:

Engineering systems must develop:

- **Support system** (**structure\science**):
- It holds the structure up so that it does not collapse. A need for **strength** to achieve this.
- It prevents elements to deform or crack excessively. A need for **serviceability** to achieve this.
- It makes the structure withstands severe events (like earthquakes, wind storms, …). A **special\stable** design is needed to achieve this (**savings** in materials: smaller sections + larger strength).

System determinants

- **Faith system (facts\fashion):**

It Defines

- space configuration based on **functional** needs (social, economical),
- The capacity of adaptation based on **freedom** needs (legal, environmental)
- geometrical shape based on **form** needs (culture, esthetics)

Standards versus codes

- Standard means an approved model or level of quality
- Code means a set of rules
- Minimum standards are controlled by design codes.
- Design codes are based on model codes which often specify a particular industry standard.
- Municipal and state governments adopt the model codes (or develop their own codes) and thus provide legally enforceable laws with which the engineer must comply.
- The intent of the code is not to limit engineering creativity, but to provide minimum standards to safeguard the health and safety of the public.

Fundamentals of Design

Input: **decompose** problem into components

know **degree** of components

draw a mathematical model

Processing: **define** laws governing mechanics

provide **details** needed to solve problem

design methodology to solve problem (manual, computer)

Output: **deliver** solution in a nice way

enhance solution to values (**dean)**

develop capability to solve problems

Decomposition

- Architectural
- Structural
- Mechanical
- Electrical
- ….
- Earthquake:
  - Geology
  - Seismology
  - Geotechnical: soil+foundation
  - Structural

Degree of components

- Structure first before architectural
- Scalar, vector, stress,…., elasticity constants

draw a mathematical model

- 1D models
- 2D models
- 3D models
- ….

Define laws

- **Laws**: conceptual according to degree
  - constitutive relationships: stress-strain relationships
  - Counter-balance: equilibrium equations
  - compatibility equations: kinematics

- **Theories**:
  - Based on:
  - Assumptions based on:
  - Available knowledge is constrained with:

Details needed: definitions

- ***Conceptual is needed at first to save time:***

"what an engineer can do on a back of an envelope cannot tons of computer output do"

Design methodology for solving problems

Input
1. Problem to be solved
2. Physics of problem
3. Mathematical model

Processing
1. Propose theory
2. Formulate equations
3. Solve equations

Output
1. Verify laws
2. Build engineering sense
3. Start a new cycle

Fundamentals of thinking: Input

- Start with present worked examples (get advantage of other thoughts-how Japan builds up quickly).

1. See (a good engineer is a good observer),
2. Read (plans of others),
3. Ask (learn how to gather hidden information making sure you are satisfied with the answer, if not then argue but be careful not to go more than one round for each point (learn how to express yourself in words))

Fundamentals of thinking: Input and Processing

- Try to solve the problem by:
  1. Study your subject first of all.
  2. Get an overview about all tasks needed for solution.
  3. Select members of your team based on qualifications: capability to do the work + commitment.

Choose a qualified team leader.

1. Divide the tasks between the team members.
2. Put a study plan (allocate time for each task + plan alternatives).
3. Think how to do your part of the work on paper (learn how to express yourself in writing).

Fundamentals of thinking: Processing and Output

- Systematical management of tasks
  1. Survey literature of the subject (system determinants). Be careful to cover all sides of the problem.
  2. Put a plan how to cover general principles before particular ones
  3. Make sure to stress the important issues and basic principles (support your work by scientific proof)

Put contents of your final report

1. Unify with your team members all symbols, wording, software …etc to be used to present the final report.
2. Perform your study plan and see how well it is.
3. Get feed back from all your team members about the whole project to decide to continue or go to alternatives

End of chapter 1

Let Learning Continue