STRUCTURAL DESIGN AND STEEL - AN INTRODUCTION

Anyone managing the construction process needs a basic understanding of the engineer‟s environment and the basic understanding of how a structure behaves. Constructors must be able to address a number of technical questions at the project site including structural issues that sometimes are not addressed by the design professionals. Since the safety of construction workers as well as the strength and stability of structures during the construction phase is of paramount importance, construction mangers need this knowledge.

Structural Design

• Definition: Determination of overall proportions and dimensions of the supporting framework and the selection of individual members.

• Responsibility:The structural engineer, within the constraints imposed by the architect (number of stories, floor plan,..) is responsible for structural design

• Safety (the structure doesn‟t fall down)

• Serviceability (how well the structure performs in term of appearance and deflection)
• Economy (an efficient use of materials and labor)

Alternatives
• Several alternative designs should be prepared and their costs compared

Types of Load
• Dead Loads (permanent; including self-weight, floor covering, suspended ceiling, Partitions.

• Live Loads (not permanent; the location is not fixed; including furniture, equipment, and occupants of buildings)

• Wind Load (exerts a pressure or suction on the exterior of a building)
Types of Load Continued

• Earthquake Loads (the effects of ground motion are simulated by a system of horizontal forces)

• Snow Load (varies with geographical location and drift)

• Other Loads (hydrostatic pressure, soil pressure)

Types of Load Continued
• If the load is applied suddenly, the effects of IMPACT must be accounted for.

• If the load is applied and removed many times over the life of the structure, FATIGUE stress must be accounted for Design Specifications.
• Provide guidance for the design of structural members and their connections.
• They have no legal standing on their own, but they can easily be adopted, by reference, as part of a building code.
• American Concrete Institute (ACI 318-99) Building Code Requirements for Structural Concrete
• National Design Specifications for Wood Construction by American Forest and Paper Association.

Structural Steel
• **Steel** is an alloy of primarily iron, carbon (1 to 2%) and small amount of other components (manganese, nickel, …)
• Carbon contributes to strength but reduces ductility.

Steel Properties
• The important characteristics of **steel** for **design** purposes are:
o yield stress (Fy)
o ultimate stress (Fu)
o modulus of elasticity (E)
o percent elongation (e)
o coefficient of thermal expansion (a)

Design Philosophies
• Allowable Stress **Design** Method (ASD)

• Load and Resistance Factor **Design** (LRFD)

A member is selected such that the max stress due to working loads does not exceed an allowable stress.

• It is also called elastic **design** or working stress **design**.

o allowable stress=yield stress/factor of safety

o actual stress Í allowable stress

LRFD –Load and Resistance Factor Design

• A member is selected such that its factored strength is more than the factored loads.

o S(loads x L factors) Í resistance x R factor

• Each load effect (DL, LL, ..)has a different load factor which its value depends on the combination of loads under consideration.

Load Factors

• The values are based on extensive statistical studies

o DL only 1.4D

o DL+LL+SL (LL domin.) 1.2D+1.6L+0.5S

o DL+LL+SL (SL domin.) 1.2D+0.5L+1.6S

o In each combination, one of the effects is considered to be at its "lifetime" max value and the others at their "arbitrary point in time " values.

Resistance Factor

• The resistance factors range in value from 0.75 to 1.0 depending on the type of resistance (tension, bending, compression, ..)

• These factors account for uncertainties in material properties, **design** theory, and fabrication and construction practices.

History

• ASD has been the primary method used for **steel design** since the first AISC specifications was issued in 1923.

• In 1986, AISC issued the first specification for LRFD.

• The trend today is toward LRFD method, but ASD is still in use.

Advantages of LRFD

• It provides a more uniform reliability in all structures subjected to many types of loading conditions. It does not treat DL and LL as equivalent, thereby leading to a more rational approach.

• It provides better economy as the DL make up a greater percentage on a given structure. Because DLs are less variable by nature than live loads, a lower load factor is used.

This may lead to a reduction in member size and therefore better economy

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