STRUCTURAL ANALYSIS AND DESIGN CEGE0009

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(GM10)

PHILOSOPHY OF DESIGN

OBJECTIVES IN DESIGN

THE NORMALLY ACCEPTED OBJECTIVES ARE THAT A STRUCTURE SHOULD

- FULFIL ITS INTENDED PURPOSE
- REMAIN SAFE ND SERVICEABLE IN USE
- BE ECONOMICAL TO BUILD AND MAINTAIN
- BE AESTHETICALLY PLEASING

INPUTS INTO DESIGN

- CLIENTS BRIEF
- EXPERIENCE OF DESIGN AND CONSTRUCTION
- IMAGINATION
- SITE INVESTIGATION
- MODEL AND LABORATORY TESTS
- ECONOMIC FACTORS
- ENVIRONMENTAL FACTORS
- LOADING
- MATERIAL STRENGTHS
- HEALTH AND SAFETY

PROCESSES IN DESIGN

THE ENGINEERING DESIGN PROCESS IS NORMALLY DIVIDED INTO TWO STAGES:

1. A FEASIBILITY STUDY
2. DETAILED DESIGN

VARIABLES IN STRUCTURAL DESIGN

THE PRIMARY VARIABLES ARE:

1. STRENGTH OF MATERIALS
2. LOADINGS TO BE CARRIED

THE PRINCIPAL AIM OF STRUCTURAL DESIGN IS TO ENSURE THAT (1) > (2).

BUT IF (1) >> (2), UNECONOMICAL DESIGN RESULTS

THE NORMAL DISTRIBUTION CURVE ON THE LEFT REPRESENTS THE VARIATION IN LOADING DUE TO CHANGES IN OCCUPANCY WHEREAS THE CURVE ON THE RIGHT REPRESENTS THE VARIATION IN MATERIAL STRENGTHS.

THE OVERLAP BETWEEN THE CURVES REPRESENTS A POSSIBILITY THAT FAILURE MAY OCCUR.

COMPARATIVE DEATH RISK PER HOUR PER 10^8 PERSONS EXPOSED

ACTIVITY	RISK
MOUNTAINEERING	2700
AIR TRAVEL	120
DEEP WATER TRAWLING	59
CAR TRAVEL	56
COAL MINING	21
CONSTRUCTION SITES	7.7
MANUFACTURING	2
ACCIDENTS AT HOME	2.1
FIRE AT HOME	0.1
STRUCTURAL FAILURE	0.002

TO INCREASE THE LEVEL OF SAFETY USUALLY ENTAILS EXTRA COSTS

THE AIM OF ALL STRUCTURAL DESIGN IS THAT THERE IS AN ***ACCEPTABLE LEVEL OF RISK*** AGAINST FAILURE

THIS CAN BE ACHIEVED USING EITHER OF <u>THREE</u> DISTINCT DESIGN PHILOSOPHIES:

1. PERMISSIBLE STRESS DESIGN
2. LOAD FACTOR DESIGN
3. LIMIT STATE DESIGN

PERMISSIBLE STRESS DESIGN

THIS APPROACH INVOLVES LIMITING THE MAXIMUM MATERIAL STRESS UNDER WORKING LOAD TO A PROPORTION OF THE YIELD STRESS.

THE PERMISSIBLE STRESS IS THE YIELD STRESS DIVIDED BY A FACTOR OF SAFETY.

LOAD FACTOR METHOD

THIS APPROACH INVOLVES CALCULATING THE COLLAPSE LOAD OF THE STRUCTURE.

THE WORKING LOAD IS OBTAINED BY DIVIDING THE COLLAPSE LOAD BY A LOAD FACTOR.

LIMIT STATE DESIGN

CONSIDERS THE VARIOUS MECHANISMS WHICH COULD RENDER A STRUCTURE UNFIT FOR USE e.g.

- EXCESSIVE BENDING
- SHEAR
- COMPRESSION
- DEFLECTION

EACH OF THESE MECHANISM IS TERMED ***A LIMIT STATE*** WHOSE EFFECT ON THE STRUCTURE MUST BE INDIVIDUALLY ASSESSED.

SERVICEABILITY AND ULTIMATE LIMIT STATES

LIMIT STATES WHICH PRIMARILY AFFECT THE APPEARANCE AND/OR IMPAIR PROPER FUNCTIONING OF THE STRUCTURE e.g. DEFLECTION, CRACKING, CORROSION, ETC., ARE TERMED ***SERVICEABILITY LIMIT STATES***.

LIMIT STATES THAT CAN CAUSE PARTIAL OR COMPLETE COLLAPSE OF THE STRUCTURE e.g. DENDING, SHEAR, COMPRESSION, ETC., ARE TERMED ***ULTIMATE LIMIT STATES***.

CHARACTERISTIC AND DESIGN STRENGTHS

MATERIAL STRENGTHS MAY BE LESS THAN INTENDED BECAUSE OF

1. VARIABILITY OF MATERIAL COMPOSITION
2. VARIABILITY OF MANUFACTURING CONDITIONS DURING CONSTRUCTION

ALLOWANCE FOR THE EFFECT OF ITEM (1) IS MADE BY USING A ***CHARACTERISTIC STRENGTH*** WHICH IS THE STRENGTH BELOW WHICH NOT MORE THAN A SMALL PERCENTAGE, TYPICALLY 5%, OF TEST RESULTS FALL.

ALLOWANCE FOR THE EFFECT OF ITEM (2) IS MADE BY USING A ***PARITAL SAFETY FACTOR*** (FOR MATERIAL STRENGTH, γ_m) WHICH REDUCES THE CHARACTERISTIC STRENGTH TO A ***DESIGN STRENGTH***.

CHARACTERISTIC AND DESIGN LOADS

THE LOADING ON A STRUCTURE MAY BE ***GREATER*** THAN ANTICIPATED BECAUSE OF

1. VARIABILITY OF THE OCCUPANCY
2. UNFORSEEN CIRCUMSTANCES e.g. ERRORS IN ANALYSIS, ERRORS DURING CONSTRUCTION, ETC

ITEM (1) IS ALLOWED FOR BY USING ***CHARACTERISTIC LOADS*** i.e. LOADS WHICH HAVE AN ACCEPTABLY SMALL PROBABILITY OF NOT BEING EXCEEDED DURING THE LIFE OF THE STRUCTURE.

ITEM (2) IS ALLOWED FOR USING A ***PARITAL SAFETY FACTOR*** (FOR LOADING, γ_f) WHICH INCREASES THE CHARACTERISTIC LOAD TO A ***DESIGN LOAD***.