Computer Aided Planning and Design of a School Building

PROJECT REPORT

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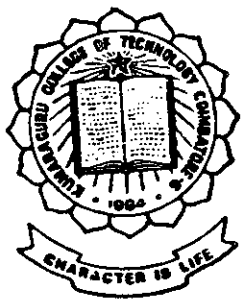


Submitted by

KOKILAM P.

ABHIRAMAVALLEE B.

MUTHUVANNAN D.

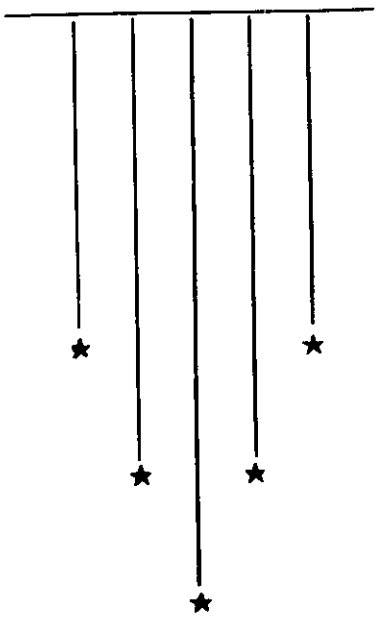
Guided by

Mr. D. L. VENKATESH BABU, M.E.,

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE AWARD OF THE DEGREE OF

BACHELOR OF ENGINEERING IN CIVIL ENGINEERING

OF THE BHARATHIAR UNIVERSITY, COIMBATORE



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DEPARTMENT OF CIVIL ENGINEERING

Kumaraguru College of Technology

COIMBATORE 641 006

Kumaraguru College of Technology

Coimbatore - 641 006.

Department of Civil Engineering

Certificate

This is to Certify that the Report entitled

Computer Aided Planning and design of a School Building

Has been submitted by

Mr./Ms [illegible]

in partial fulfilment of the requirements for the award of Degree of Bachelor of Engineering in the Civil Engineering Branch of the Bharathiar University, Coimbatore-641046 during the academic year 1996-97.

(Guide) (Head of Department)

Certified that the Candidate was Examined by us in the Project Work Viva-Voce Examination held on _____ *and the University Register Number is* _____

(Internal Examiner) (External Examiner)

ACKNOWLEDGEMENT

We extend our heartiest gratitude to the Almighty for the successful completion of the project.

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We also extend our sincere thanks to all those who helped us in the successful completion of this project.

SYNOPSIS

This project deals with the planning and design with detailed architectural and structural drawings of a school building with the aid of the computer.

The layout details of the proposed site was sponsored. It is a typical R.C.C framed structure. The detailed architectural and structural drawings showings the plan of various components, site plan, elevation, sectional elevation have been shown.

Moment distribution method is used for the calculation of shear force and bending moments of the school building. Limit state method is adopted in the design of all structural components as per National building code of India, 1983. A programming language in `c' has been used for design.

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1. INTRODUCTION

1.1 OBJECT:

The aim of our project is to design a school building at KALLAR by developing a computer programme in `C' language. The analysis is carried out as per IS standards. The design of various components has been done based on LIMIT STATE method of design in accordance with IS:456 - 1978.

The advantage of having developed this software is that a number of options of any proposed components of building can be tried out and the best economical design can be arrived in a short time.

`C' the most convenient and widely employed language for engineering applications has been used.

The proposed site at KALLAR is located 5 Kilometers away from METTUPALAYAM and 45 Kilometers from COIMBATORE on Ooty-

Mettupalayam road. A private road which connects the site and main road is parallel to railway line.

Kallar is about 45Kms away from Coimbatore - far away from sub urban area - at the foot hills of Ooty offers a very pleasant- and is very scarcely populated. Due to its segregation from sub urban area, traffic hazards are minimised.

The important criterian for school planning at Kallar is that, the site selected for the school are by and large, located in places where there is not much of population, climate is pleasant and very healthy and easily assessible.

The environment of Kallar is such that it is conducive and ensures full comfort to the student. The type of district, its future use and zoning play an important role in environment conditions.

1.2 `C' PROGRAM FEATURES:

The use of computer is inevitable in all fields of engineering viz business, government, military, engineering and scientific research. Computers have also demonstrated to be a very powerful weapon in the design, planning and construction management.

Computer aided design involves any type of activity which utilises computer for the development, analysis and modification of an engineering design.

Various design related tasks that are performed in our project includes:

1. Engineering analysis.
2. Design review and evaluation.

INTRODUCTION TO `C'

`C' is a general purpose, structural programming language, its instructions consists of terms that resemble algebraic expressions, augmented by certain English Keywords such as if, else, for, do and while. In this repeat, `C' resembles other high-level structured programming languages such as

Pascal and fortran-77. `C' also contains certain additional features, however, that allow it to be used at a lower level, thus bridging the gap between machine language and the more conventional high-level languages. This flexibility allows `C' to be used for systems programming as well as for applications programming.

C is characterized by the ability to write very concise program, due in part to the large number of operators included within the language. It has a relatively small instruction set, though actual implementation include extensive library functions which enhance the basic instructions. The language, also encourages users to write additional library functions of their own. Thus, the features and capability of the language can be extended by the user.

C computer are commonly available for computers of all sizes, and C interpreters are becoming increasingly common. Another important characteristic of C is that its programs are highly portable, even more so than with other high-level languages. The reason for this is that C relegates most

computer dependent features to its library functions. Thus, most C programs can be processed on many different computers with little (or) no alteration.

HISTORY OF C

C was originally developed in the 1970's by DENNIS RITCHIE at Bell telephone laboratories, Inc. It is an outgrowth of two earlier languages, called BCPL and B, when were also developed at Bell Laboratories. C has largely confined to use with in bell laboratories until 1978, when Brian Kernighan and Ritchie published a definitive description of the language. Moreover, many commercial software products that were originally written in other languages were rewritten in C in order to take advantage of its efficiency and its portability.

STRUCTURE OF `C' PROGRAM

Every C-Program consists of one (or) more functions, one of which must be called main. The program will always begin executing the main function.

The each function contains:

1) A function heading, which consists of the function name.

followed by an optional list of arguments enclosed in parentheses.

2) A list argument declarations, if arguments are included in the heading.

3) A compound statement, which comprises the remainder of the function.

PLANNING

PLANNING OF SCHOOL BUILDING

Planning is essential for efficient execution of the project and to achieve economy, keeping in view, the importance of the project. Planning involves foreseeing all the conditions and contingencies, which may develop during the period of construction and taking advance action. The feasibility of a scheme must be examined by preliminary planning and investigation and planning of the project can be undertaken. The planning must incorporate maximum utility and permanence, good proportion and grace.

EDUCATIONAL BUILDINGS

This includes primary and secondary schools; arts, science, commerce, law colleges; technical, medical and agricultural colleges or institutions.

The units required are :

(a) Entrance (or) Reception,

(b) Office and Administrative block.

(c) Classrooms:

1.Students below 10 years - Area 1-1.2 sqm/student.

2.Students above 10 years - Area 1.2-1.5 sq.m/student

GENERAL SIZES

1. 4.5 M X 6.0 M
2. 5.5 M X 6.5 M
3. 6.0 X 7.2 M
4. 6.0 X 7.8 M
5. 7.0 X 10.0 M

d) Teacher's room - 14 Sq m.

e) Drawing halls - Area 3-4 sq m/student

f) Laboratories - Area 3-4 sq m / student

g) Assembly hall - Area 0.5-0.6 sq m / student

h) Library - Area 80-95 sq m for 1500 students

i) Parking space and cycle stands

j) Sanitary block

DESCRIPTION	MALE	FEMALE
W.C	1 for 40 students	1 for 25
Urinals	1 for 20 students	___
Wash basins	1 for 40 students	1 for 40
Water taps	1 for 50 students	1 for 50

RULES FOR SCHOOL BUILDINGS

1. Permissible built area 1/4 plot area.
2. Only ground and upper two allowed

3. Minimum area of classroom - 38 sq m.
4. Light and ventilation not less than 1/5th of the carpet area of classroom.
5. Height of classroom - 3.6 m minimum.
6. One staircase after 15.25 m length
7. Width of staircase 1.25 m minimum
8. Passages in building 2.5m.
9. One Urinal for 50 students
10. One W.C. per 100 students

SPACE REQUIREMENT

Space requirement for every individual unit in a building depends upon its function. Buildings consists of different units or rooms. Each rooms have specific functions and these units have a definite relations with their adjoining and other units with regard to function and convenience. These units may be connected with each other by means of a passage, lobby, verandah or staircase.

The points to be considered for space requirements are:

1. Regulations and bye - law of the plan sanctioning authority.

2. Establishment of areas for different units

    a) Function

    b) Number of persons

    c) Furniture requirements, etc.,

3. Roominess

4. Flexibility

5. Sanitation

6. Requirements for air conditioning / central heating, acoustics, equipment and other provisions.

7. Cubical requirements for ventilation

THE SITE SELECTION

One of the first and most important aspects of school plant planning is site and development.

A score card should be developed for placing the various site characteristics in their proper perspective. The card will provide a factual and realistic on which to make an unbiased, unemotional and non-political decision.

This card present a complete site analysis and include such items as:

(1) ACCESSIBILITY

Accessibility is an important aspect taken into considerations. The school be accessible from the centre of the town. It should be located in a place where traffic hazards are minimized.

Moreover, the other necessities like air circulation, light, noise, etc.. are to be considered. For sufficient fresh air circulation, well designed and

bold corridors are the answer. A lot of care should be taken to see that every part of the classroom receives the same amount of light.

2. ENVIRONMENT & ATMOSPHERIC CONDITION

Environment plays an important role in the site selection. The type of district, its future use and zoning plays an important role in environment conditions. Smoke, dust and colours adversely affect health and comfort.

The environment of kallar is such that it is conducive and ensures full comfort to the students. The area is free from dust, smoke, etc, due to the absence of any residential or industrial area offering an hygenic environ. There is no light obstruction for the place. The place has many contours surrounded by forests on one side and mountains on the other side and this gives a panoramic vista. It promotes for the student's activities successfully which will help, widening his mental horizon. The contoured areas has natural drainage facilities.

Since the site is isolated from the sub-urban area, the noises and also from smoke and dust, thus making the environment hygenic.

Smoke, dirt and odours adversely affect health and comfort. They can also deliver telling blows to the pocket book section, making operation and maintenance cost soon.

There is no residential zone nearer to the site. But the nearest town is Mettupalayam which is about 5 Kms away from kallar, brings in proximity for all public services.

(3) TOPOGRAPHY AND SOIL

The site is a highly contour site with grade elevations. The slope of the site varies from 1 in 20 in the middle of the site and 1 in 10 on the eastern side.

(4) NOISE

If there is noise, they become magnified when they seep through school windows, because of the relative quiet of the class.

(5) LIGHT OBSTRUCTION

Natural sunlight is good and it is free. The prospective site should be surveyed for any light obstructions, present or contemplated.

(6) PROXIMITY TO OTHER FACILITIES:

Proximity is also very essential. On no account should be isolated from such facilities. Sometimes the land is extremely undeveloped and unsuitable for establishing a school. The land must be well developed, with natural drainage, water pipe arrangement and other public services must be easily accessible to it.

(7) SIZE

This element in site selection grows more important every year. It is more important every year. It is more important, in the opinion of many, than accessibility.

The first consideration, the statistical factor of play area per pupil, is important. But the question of size goes far beyond that. It is important that the site being large enough so that the school buildings and play areas can be removed from the street. Provision also should be made for expansion. additions off the plant and additions to the site itself should be considered.

(8) COMPOSITION

The essential functions of school are:

ACADEMIC

RESIDENTIAL

RECREATIONAL

The most important criterian for school planning is that, the sites selected for the schools are by and large located in places where there is not much of population, climate is pleasant and very healthy and easily accessible. The answer to all these needs, in choosing the site, is the hills.

Acoustics is yet another aspect to be tabled well. No student be at any disadvantage as not to hear what is taught. What is tutored, should be audible without any effect or strain.

INSTRUCTIONAL SPACE

CLASS ROOMS

The developement of the teaching process, extension of class rooms activities and use of group techniques within the class room have led to new class room design in recent years. Square class rooms have been providing more satisfactory than rectangular ones. The area of the class room is increasing with the realization that small class rooms of the past have been the greatest handicap to the improvement of the educational program.

GENERAL REQUIREMENTS FOR ALL CLASS ROOMS

1. Sufficient space is needed near the front of the room for setting up audio-visual equipment, such as projection screens and charts.

2. Ceiling should be a minimum of 3.4 m and maximum of 4.5 m.

3. Light from windows should, if possible come over a pupil's left shoulder. No teacher should be required to face the windows when addressing the class room from the normal teaching position.

4. Tack boards in the class room will also help acoustic condition.

THE SIZE OF THE CLASS ROOM

The size of a class room depends upon the number of the pupils in the class, and the extent of air space to be allowed to each pupil is 2.78 sq.m. The minimum being 1.85 sq.m, the height of the class room should not exceed 4.5 m. A very high room will mean more cost, without any commensurate advantage. Besides, a very high room is hard to ventilate or decorate easily. Cobwebs are formed and cleaning presents a problem. A low room will be dark and dingy. Class rooms with a height of 3.0 m. becomes stuffy very quickly.

LOCATION

The class room should have, as quite a location as possible, away from noisy areas. Ease of access to specialized facilities outside the academic unit should be ensured.

DOORS

1. Doors should be placed at the front of the class room and should be recessed so that they do not protrude into the corridor.

2. Thresholds should be avoided that equipment or wheeled tables such as mounted movie projectors can be rolled in and out easily.

3. All doors should have a vision panel of tempered or wire glass.

4. Doors hardware should be such that doors cannot be locked from inside the class rooms.

FACTORS TO BE TAKEN INTO CONSIDERATION WHILE PREPARING PLAN OF A BUILDING

ADEQUACY

A plant must possess adequately and all the facilities necessary for curricular and co-curricular activities.

SAFETY

The school plan must be able to project the health of the pupils and teachers. It must have proper ventilation and light and guard against common building hazards like 1. Fire 2. Sudden dilapidation, 3. Electric combustion, 4. Unsanitary drinking taps, 5) floods or water clogging, 6) Beehives is very necessary.

CO-ORDINATION

All the section of the school campus must function separately and must be connected mutually so as to help and not interfere class-room, and the staff room very near the principal's room. The building must be so set. and regulation of movements so defined so as to minimise traffic.

ADAPTABILITY

There must be no rigidity in the design and use of the plant. It must be planned in a flexible way so as to leave scope for modification in accordance with the need.

ECONOMY

The school plant should be "Economical in original cost, upkeep and operation."

SITE AND SANITATION

The importance of site and sanitation for a school campus cannot be overestimated. A bad site will be detremental to the physical health of the pupils. A ugly and unhygienic building has also a bad effect on the minds of the pupils. Positively the site and sanitation must `Install into the minds of the children a knowledge of the laws of health' and must also inculcate in them the love for the school.

MAINTENANCE OF THE SCHOOL

These includes the following task:

1. Maintenance of school lawn, the flower beds, the budge and the tuff.
2. Maintenance of the play grounds, the levelling, marking and keeping them hidy.
3. Maintenance of the school building, regular cleaning, white washing, colour washing and repairing.
6. The safety and and security of the school properly
7. Keeping the whole school campus neat and tidy.

ANALYSIS

3.1 MOMENT - DISTRIBUTION METHOD

CALCULATION OF LOADINGS

SLAB

Assume the thickness as 125 mm for slab.

BEAM

Assume size of the Beam as 9" x 15"

$$B_1 = 230 \times 380 \text{ mm}$$

Assume size of the Beam as 9" x 24"

$$B_2 = 230 \times 610 \text{ mm}$$

WALL

Assume the thickness of wall as 230 mm

Height of the wall = 10' = 3m

Assume self weight of brick = 20,000 N/m^3

COLUMN

Assume the size of the column = 9" x 15"

= 230 x 380 mm

SLAB LOAD

Assume live load of slab = 3000 N/m^2

Finishing load = 1000 N/m^2

Self weight of slab = 25000 x 0.125 x 1

= 3125 N/m

Self weight of Beam B_1 = 25000 x 0.23 x 0.38

= 2185 N/M

Self weight of Beam B_2 = 25000 x 0.23 x 0.61

= 3507.5 N/M

Self weight of the wall = 20000 x 0.23 x 3.0

= 13800 N/M

Self weight of the column = 0.23 x 0.28 x 3 x 25000

= 6555 N

GROUND FLOOR

COLUMN LOADING : - (c1)

Slab load to column = 7125 x 6.33 x 3.07 x 2

= 276.92 KN

Beam load (B1) to column = 2185 x 3.0 x 2

= 13.416 KN

Beam load (B2) to column = 3507.5 x 6.33 x 2

= 44.40 KN

Wall load to column = 13800 x 3.07 x 1

= 42.87 KN

Column load = 6555 x 2 = 13.11 KN

Total on column = 390.22 KN

BEAM LOAD: (B_1)

Self weight of Beam = 2185 N/m

Load from slab = 90.20 KN/MLoadfrom wall

Load from wall = 13.80 KN/M

Total load = 106.19 KN/m

MOMENT DISTRIBUTION METHOD

STIFFNESS FACTOR

$$K_{AB}\backslash B = I_{AB}/L_{AB} = (0.23 \times (0.61)^3/12)/6.33 = 6.87 \times 10^{-4}$$

$$K_{AD} = I_{AD}/l_{AD} = 0.23 \times ((0.38^3/12)/300) = 3.51 \times 10^{-4}$$

$$K_{AC} = 3.51 \times 10^{-4}$$

DISTRIBUTION FACTOR

$$r_{AB} : r_{AD} : r_{AC} : K_{AB}/K_{AB} + K_{AD} + K_{AC} = K_{AD}/ K_{AB} + K_{AD} + K_{AC}$$

$$= K_{AC}/K_{AB} + K_{AD} + K_{AC}$$

$$= 6.87 \text{ X } 10^{-4}/1.389 \text{ X } 10^{-3}$$

$$= 3.51 \text{ X } 10^{-4}/1.389 \text{ X } 10^{-3}$$

$$= 3.51 \text{ X } 10^{-4}/1.389 \text{ X } 10^{-3}$$

$$= 0.50 \quad = 0.25 = 0.25$$

FIXED END MOMENT

$$M_{AB} = wl^2/12 = 106.19 \times (4.84)^2/12 = 207.30 \text{ KN.m}$$

$$M_{BA} = -207.30 \text{ KN.m}$$

Joint	A	
Member	AB	AD
D.F	0.5	0.25
FEM	207.3	-
B.D	-103.65	-51.825
C.D	-51.825	-
B.D	25.9125	12.9563
	77.74	-38.87

Beam moment = 77.74 KN.m

Column moment = -38.87 KN.m

PRINCIPAL, STAFF ROOM:

COLUMN C_2

Load from slab = 7125 x (6.25/2) x 4.845/2 x 2

= 113.57 KN

Load from beam (1) to column = 2185 x 4.845/2 x 2 = 10.59

Load from beam (2) to column = 3507.5 x 6.58/2 = 23.08 KN.

Wall load to column = 13800 x 6.58/2 x 1 = 45.4 KN.

Column load = 6555 x 2 = 13.11 KN.

Total load on column = 205.75 KN.

BEAM LOAD B_2

Load from slab = 57.61 KN/m

Beam load = 3.51 KN/m

Wall load = 18.8 KN/m

Total load = 74.92 KN/m

MOMENT DISTRIBUTION METHOD

STIFFNESS FACTOR

$K_{AB} = ((0.23 \times (0.61)^3/12)/ 6.33) = 6.87 \times 10^{-4}$

$K_{AD} = ((0.23 \times (0.38^3/12)/3.0) = 3.51 \times 10^{-4}$

$K_{AC} = 3.51 \times 10^{-4}$

DISTRIBUTION FACTOR

$r_{AB} : r_{AD} : r_{AC} = 6.61 \text{ X } 10^{-4}/1.363 \text{ X } 10^{-4}$

$= 3.51 \text{ X } 10^{-4}/1.363 \text{ X } 10^{-4}$

$= 3.51 \text{ X } 10^{-4}/1.363 \text{ X } 10^{-4}$

$= 0.48 : 0.26 : 0.26$

FIXED END MOMENT

$M_{AB} = Wl^2/12 = 74.92 \times (6.58)^2/12 = 270.31$ KN.m

$M_{BA} = -270.31$ KN.m

Joint	A	
Member	AB	AD
D.F	0.48	0.26
FEM	270.31	
B.D	-129.75	-70.28
C.O.	-64.875	-
B.D	-31.14	16.87
	106.825	-53.41

Beam moment = 106.825 KN.m

Column moment = -53.41 KN.m

BOYS TOILET

BEAM LOAD B_3

Load from Slab = 7125 x 1.595 = 11.36 KN/m

Self weight of beam = 2.185 KN/m

Total load = 13.55 KN/m

MOMENT DISTRIBUTION METHOD

$K_{AB} = ((0.23 \times (0.38)^3/12)/ 3.19) = 3.30 \times 10^{-4}$

$K_{AC} = ((0.23 \times (0.38^3/12)/3.0) = 3.51 \times 10^{-4}$

$K_{AB} = 3.51 \times 10^{-4}$

DISTRIBUTION FACTOR

$r_{AB} : r_{AD} : r_{AC} = 3.3 \times 10^{-4} / 1.032 \times 10^{-4}$

$= 3.51 \times 10^{-4} / 1.032 \times 10^{-4}$

$= 3.51 \times 10^{-4} / 1.032 \times 10^{-4}$

$= 0.32 : 0.34 : 0.34$

Joint	A	
Member	AD	AD
D.F	0.32	0.34
FEM	11.49	-
B.D	-3.69	-3.91
C.O	-1.845	-
B.D	0.59	0.63
	6.56	-3.28

Beam moment = 6.56 KN.m

Column moment = - 3.28 KN.m

VICE PRICIPAL , STAFF, OFFICE ROOM

COLUMN LOAD C_3

Load from slab = 7125 x (6.58/2) x 3.53/2 x 2

= 82.74 KN

Load from beam (1) to column = 2185 x 3.53 /2 x 2 = 82.74 KN.

Load from beam (2) to column = 3507.5 x 6.58/2 = 23.08 KN.

Load from wall = 13.8 x 6.58/2 = 45.4 KN.

Column load = 6555 x 2 = 13.11 KN

Total load on column = 172.04 KN

BEAM LOAD B_4

Self weight of beam = 3.5075 KN/m

Load from slab = 55.29 KN/m

Wall load = 13.8 KN/m

Total load = 71.74 KN/m

MOMENT DISTRIBUTION

$K_{AB} = 6.61 \times 10^{-4}$

$K_{AB} = 3.51 \times 10^{-4}$

$K_{AD} = 3.51 \times 10_{-4}$

DISTRIBUTION FACTOR

$r_{AB} : r_{AD} : r_{AC} = 0.48 : 0.26 : 0.26$

FIXED END MOMENT

$$M_{AB} = wl^2/12 = 258.84 = 270.31 \text{ KN.m}$$

$$M_{BA} = -270.84 \text{ KN.m KN.m}$$

Joint	A	
Member	AB	AD
D.F	258.84	-
B.D	-124.24	-67.3
C.O	-62.125	-
B.D	29.82	16.15
	102.3	-51.15

Beam moment = + 102.3 KN.m

Column moment = -51.15 KN.m

FIRST FLOOR

COLUMN I

Total load = 174.29 KN

BEAM I

Total Load = 49.19

Beam moment = 97.73 KN.m

Column moment = -48.86 KN.m

PRINCIPAL AND STAFF ROOM

Beam moment = 50.224 KN.m

Column moment = -50.224 KN.m

BOYS TOILET

Beam moment = +3.08 KN.m

Column moment = -3.08 KN.m

VICE PRINCIPAL , STAFF, OFFICE ROOM

Beam moment = +48.37 KN.m

Column moment =-48.37 KN.m

LIBRARY

Beam moment = 43.87 KN.m

Column moment = -43.87 KN.m

SPORTS STORE

Beam moment = 24.02 KN.m

Column moment = -24.02 KN.m

BOYS TOILET AND GIRLS TOILET

Beam moment = 7.121 KN.m

Column moment = -7.131 KN.m

DESIGN

4.1 LIMIT STATE METHOD

Limit stage method is based on probability concept. The structure is analysed at the failure. The strength of concrete and steel is worked by probability concept to ensure correct available strength. Partial safety factors are introduced to reduce the probability of failure to at most zero. For concrete, factor of 1.5 and for steel 1.15 is taken. The factor for loading is 1.5 limit state of serviceability and cracking are also considered. Limit state method is more logical to the actual behaviour of the structure under various loads, Indian standard IS:456-1978 has introduced the use of this method from 1979.

economic percentage, but this may be misloading since the relative amounts of steel and concrete in the mist economical design depend not only on permissible stresses but also on the cost of materials.

1. The load on the beam is calculated (W)
2. The maximum bending moment is found using M = W x l x /8 formula
3. Assuming the section to be balanced, find the depth of the beam. M = Q x b x d x d.
4. Find the area of steel Ast = M/st x jd
5. Check for shear and spacing of stirrups is calculated
6. Check for End Anchorage
7. Check for deflection

The value of fck : 15

Enter the value of span 1 in metres : 6.33

Enter the value of width of beam in mm : 230

Enter the value of depth of beam D in mm : 610

Enter the load in KN/m : 4

The value of depth is 570.000000 mm.

The moment is 65.794382 KN/m

Adopted depth is safe

The value of ast is 344.926056 sq.mm

Use 16mm dia bars

No of bars is 2 Numbers.

Area adopted is 628.000000

Check for shear

V=75.664795

The value of p is 0.263101 %

Please enter the value of Tc by referring the code book: 0.4

tv and tc: 0.577153 and 0.400000

Provide Shear reinforcement

10mm dia two legged stirrups are used.

The spacing adopted is 450mm c/c.

DESIGN OF SLABS

Slabs are plane structural members whose thickness is quite small as compared to its other dimensions, slabs are most frequently used as roof coverings and floors in various shapes. The slabs are designed just like beams keeping the breadth of such a beam as unity.

The slabs must be designed either as one way slab or two way slab. This depends on the ratio of spans in both direction.

If ly/lx < 2, two way slab in designed

If ly/lx > 2, One way slab in designed.

Slabs are designed by means of limit state method as per IS:456 provisions Materials used are M15 Steel and Fe415 steel.

DESIGN PROCEDURE

1. The slab thickness is assumed as per deflection given in IS:456 clause 22.21

Mu = 0.136 x fck x B x d x d.

Where Mu - factored bending moment

b - Breadth of slab

d - Effective depth of slab

fck - Characteristic compressive strength of concrete.

7. If the effective depth found is too less or greater than the effective depth assumed, then depth of slab is revised.

8. The reinforcement corresponding to any moment is calculated using the formula given in IS: 456 Appendix E.

9. After calculating the area of reinforcement, spacing and number of bar required are calculated.

10. Minimum reinforcement as per IS:456 provisions are allowed.

Distribution of steel 0.12 % of total area of cross section for Fe415.

11. Spacing;

The spacing should not exceed 3d or 450mm whichever is less.

Enter the value of fy :415

Enter the value of mf : 0

Enter the value of wp in KN/m : 3.125

Enter the value of finish wf in KN/m : 1

Enter the value of liveload in KN/m :3.0

Enter the value of centre to centre span1 : 3.00

Enter the value of centre to centre span 1x : 3.07

Enter the value of centre to centre span 1y : 6.33

The slab is two way slab

If one way slab please enter 1 else enter 2 for two-way slab.

DESIGN OF COLUMNS

The design of column necessitates determination of loads transferred from beam at different floor levels. Loads are transferred from slabs to beams and then to columns. This method enables one to assess the loads of column. More accurately and there by the design of column becomes realistic and economical.

The load on the column and effective lengths are determined. The column which have total loads on them not varying be more than 10% to 20% may be grouped together. The columns are designed for direct compression and axial bending. the columns are designed by limit state method of design using design aids SP16 charts. In column design, M20 mix and Fe415 are used.

DESIGN PROCEDURE

1. First the axial load, factored moments in x-x and y-y direction from frame analysis are taken.
2. Minimum eccentricity = L/500 + D/30 subject to a minimum of 20 mm.

Where L = unsupported length.

D = Maximum lateral dimension.

Maximum moment = minimum eccentricity X axial load.

3. The percentage of steel (p) is assumed.

4. d'/D and Pu/Fck bD ratio are calculated and design charts are referred Mux, Muy which are uniaxial moment capacities are calculated.

where d' = clear cover

D = depth of beam

Pu = axial load

5. Then Pu/Puz and safe value of Muy/Muy' for corresponding Mux/Mux' value are calculated.

6 The safe value of Muy/Muy' is compared with actual value and it should always be greater then actual value.

Enter axial load in N : 2000

Enter mx, my in N - mm :2000,

Enter the dia in mm : 25

Enter the value of fck : 15

Enter the value of fy : 415

Input omega for : ux = 0.00, uy=0.00,nu=0.00

Enter omega value :1.0

Column no: 1

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DIAMETER OF THE BAR : 25MM

THE TOTAL REINFORCEMENT IS : 6506.0239258 SQ.MM

THE REINFORCEMENT IS :-1626.5059814 SQ.MM
IN EACH CORNER

PROVIDE 4 BAR(S) OF 25 MM DIA IN EACH CORNER AND MIDDLE OF THE LONGER SIDE

TOTALLY PROVIDED 16 BAR(S) OF 25 MM DIA

****

DESIGN OF FOOTINGS

Footing distribute the load over a wider area because the base of the member transmitting load soil is made wider. Column footing when provided for independent columns are called isolated or independent footing. It is provided to distribute the concentrated loads in the form of uniformly distributed load on the soil below.

Footing shall be designed to sustain the applied loads, moments and forces and the induced reactions and to ensure that any settlement which may occur shall be as nearly uniform as possible and the safe bearing capacity of soil is not exceeded. Individual footing to distribute the load of a column to the soil is called 'Isolated footing'.

DESIGN PROCEDURE

1. Assume the self weight of footing as some percent of column load.
2. Calculate total load.
3. Area of footing required = total load/ bearing capacity of soil.

4. Calculate the bearing pressure q_o = w/Area of footing provided.

5. Calculate Moment capacity

$$Mxx = q_o/24[(2L+a)((B-b)^2)].$$

$$Myy = q_o/24[(2B+b)((L-a)^2)].$$

6. Calculate depth and Area of steel.

7. Check for shear.

8. If $Tc < Tv < 1.5\ Tc$ provice shear reinforcement

$$Tc = 0.16\ (Fck)^{1/2}\ N/mm^2.$$

here a = larger dimension of column.

b = smaller dimension of column.

l = larger dimension of footing.

B = Breadth of footing.

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THE SIZE OF THE COLUMN IS : 230MM, 380MM

THE SIZE OF THE FOOTING IS : 900MM, 1600MM

DEPTH : 560MM

OVERALL DEPTH = 600MM

AREA OF STEEL = 1188.61 SQ.MM

PROVIDE 4 BARS OF 20MM DIA

THE SECTION IS SAFE AGAINST SHEAR

****

Enter the value of fck : 15

Enter the value of fy : 415

Enter the value of tread tr in mm : 300

Enter the value of rise ri in mm : 150

Enter the value of landing width Lw in mm : 5000

Enter the value of modification factor mf : 1.1

Enter the value of live load L.L in KN/m : 1

Enter the value of floor height fh in metres : 3

Enter the value of floor finish ff in KN/m : 1

Enter the value of width of stair wd in metres : 1.5

Please enter the value of tc from code book : 0.36

Value of number of risers : 21

Value of number of steps : 19

Value of effective depth : 473 mm

10 mm dia bars for reinfrcement with 15 mm cover

Overall depth is 493 mm

The value of mu : 917.844116 KN/m

10 mm Dia Bars are used

The value of ast is 5768.981445 Sq.mm

Number of bars : 74

Distribution steelvalve of area : 591.272705

Spacing Adopted for 8mm Dia bars : 83 mm c/c

The value of percentage of steel : 0.780551%

Please enter the value of tc from code book : 0.36

The slab is safe in shear

CONCLUSION

1. A detailed plan has been prepared taking into account the functional Utility, Economy, Feasibility, Performance and good proportion.

2. Analysis of the frame using moment distribution method and results are as follows.

BEAM

Member	Load(KN/m)	Moment(KN.m)
B_1	106.19	77.74
B_2	74.92	106.83
B_3	13.55	6.56
B_4	71.74	102.3

All the beam moments are positive moments.

COLUMN

COLUMN	Load (KN)	Moment(K.N.m)
C_1	390.22	38.87
C_2	205.75	53.41
C_3	172.04	51.15
C_4	71.74	102.3

3. Design of Structural Components by limit state method using 'C' language.

BEAM RESULTS

	Size	Length
B_1	230 x 610	6.33
B_2	230 x 610	6.58
B_3	230 x 380	3.19
B_4	230 x 610	6.33

COLUMN

Rectangular column size : 230 x 380mm

Circular column size : 230mm

Length of the column : 3.06m

4. Steel consumption ratio and percentage of steel are as follows.

STEEL CONSUMPTION RATIO

S.NO	R.C.Member	Steel Consumption
1	Beam	154.18
2	Slab	68.57
3	Column	262.89
4	Footing	53.51

STEEL PERCENTAGE

S.No	R.C.Member	Steel Consumption
1	Beam	20.05%
2	Slab	34.17%
3	Column	24.77%
4	Footing	21.00%

STEEL CONSUMPTION RATIOS IN R.C. MEMBERS

S.NO.	R.C. MEMBERS	STEEL CONSUMPTION (kg/m^3 of concrete)
1	Beam	50 to 100
2	Slab	150 to 200
3	Column	200 to 300
4	Isolating Footing	50
5	Combined/Strip Footing	100
6	Rafts	150

PERCENTAGE OF STEEL IN R.C. MEMBERS

S.NO	R.C.Members	Steel Consumption
1	Slabs	35%
2	Beams	20%
3	Columns	25%
4	Foundation	20%

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