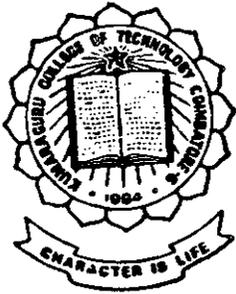


Computer Aided Planning and Design of a School Building

PROJECT REPORT

P-263



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IN PARTIAL FULFILMENT OF THE REQUIREMENTS
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DEPARTMENT OF CIVIL ENGINEERING

Kumaraguru College of Technology

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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

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*in partial fulfilment of the requirements for the award of Degree of
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1996-97.*

(Guide)

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*Certified that the Candidate was Examined by us in the Project Work Viva-Voce
Examination held on _____ and the University Register
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(Internal Examiner)

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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 criterion 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 criterion 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 development 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 detrimental 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/m³

COLUMN

$$\begin{aligned}\text{Assume the size of the column} &= 9" \times 15" \\ &= 230 \times 380 \text{ mm}\end{aligned}$$

SLAB LOAD

$$\text{Assume live load of slab} = 3000 \text{ N/m}^2$$

$$\text{Finishing load} = 1000 \text{ N/m}^2$$

$$\begin{aligned}\text{Self weight of slab} &= 25000 \times 0.125 \times 1 \\ &= 3125 \text{ N/m}\end{aligned}$$

$$\begin{aligned}\text{Self weight of Beam } B_1 &= 25000 \times 0.23 \times 0.38 \\ &= 2185 \text{ N/M}\end{aligned}$$

$$\begin{aligned}\text{Self weight of Beam } B_2 &= 25000 \times 0.23 \times 0.61 \\ &= 3507.5 \text{ N/M}\end{aligned}$$

$$\begin{aligned}\text{Self weight of the wall} &= 20000 \times 0.23 \times 3.0 \\ &= 13800 \text{ N/M}\end{aligned}$$

$$\begin{aligned}\text{Self weight of the column} &= 0.23 \times 0.28 \times 3 \times 25000 \\ &= 6555 \text{ N}\end{aligned}$$

GROUND FLOOR

COLUMN LOADING : - (c1)

$$\text{Slab load to column} = 7125 \times 6.33 \times 3.07 \times 2$$

$$= 276.92 \text{ KN}$$

$$\text{Beam load (B1) to column} = 2185 \times 3.0 \times 2$$

$$= 13.416 \text{ KN}$$

$$\text{Beam load (B2) to column} = 3507.5 \times 6.33 \times 2$$

$$= 44.40 \text{ KN}$$

$$\text{Wall load to column} = 13800 \times 3.07 \times 1$$

$$= 42.87 \text{ KN}$$

$$\text{Column load} = 6555 \times 2 = 13.11 \text{ KN}$$

$$\text{Total on column} = 390.22 \text{ KN}$$

BEAM LOAD: (B₁)

$$\text{Self weight of Beam} = 2185 \text{ N/m}$$

$$\text{Load from slab} = 90.20 \text{ KN/M}$$

$$\text{Load from wall} = 13.80 \text{ KN/M}$$

$$\text{Total load} = 106.19 \text{ KN/m}$$

MOMENT DISTRIBUTION METHOD

STIFFNESS FACTOR

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

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

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

DISTRIBUTION FACTOR

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

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

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

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

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

$$= 0.50 = 0.25 = 0.25$$

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 C₂

Load from slab = $7125 \times (6.25/2) \times 4.845/2 \times 2$
= 113.57 KN

Load from beam (1) to column = $2185 \times 4.845/2 \times 2 = 10.59$

Load from beam (2) to column = $3507.5 \times 6.58/2 = 23.08$ KN.

Wall load to column = $13800 \times 6.58/2 \times 1 = 45.4$ KN.

Column load = $6555 \times 2 = 13.11$ KN.

Total load on column = 205.75 KN.

BEAM LOAD B₂

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

$$\begin{aligned} r_{AB} : r_{AD} : r_{AC} &= 6.61 \times 10^{-4} / 1.363 \times 10^{-4} \\ &= 3.51 \times 10^{-4} / 1.363 \times 10^{-4} \\ &= 3.51 \times 10^{-4} / 1.363 \times 10^{-4} \\ &= 0.48 : 0.26 : 0.26 \end{aligned}$$

FIXED END MOMENT

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

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

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 = $7125 \times 1.595 = 11.36$ 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

$$\begin{aligned} \Gamma_{AB} : \Gamma_{AD} : \Gamma_{AC} &= 3.3 \times 10^{-4} / 1.032 \times 10^{-4} \\ &= 3.51 \times 10^{-4} / 1.032 \times 10^{-4} \\ &= 3.51 \times 10^{-4} / 1.032 \times 10^{-4} \\ &= 0.32 : 0.34 : 0.34 \end{aligned}$$

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 C₃

$$\begin{aligned} \text{Load from slab} &= 7125 \times (6.58/2) \times 3.53/2 \times 2 \\ &= 82.74 \text{ KN} \end{aligned}$$

Load from beam (1) to column = $2185 \times 3.53 / 2 \times 2 = 82.74 \text{ KN.}$

Load from beam (2) to column = $3507.5 \times 6.58/2 = 23.08 \text{ KN.}$

$$\text{Load from wall} = 13.8 \times 6.58/2 = 45.4 \text{ KN.}$$

$$\text{Column load} = 6555 \times 2 = 13.11 \text{ KN}$$

$$\text{Total load on column} = 172.04 \text{ KN}$$

BEAM LOAD B₄

$$\text{Self weight of beam} = 3.5075 \text{ KN/m}$$

$$\text{Load from slab} = 55.29 \text{ KN/m}$$

$$\text{Wall load} = 13.8 \text{ KN/m}$$

$$\text{Total load} = 71.74 \text{ KN/m}$$

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 misleading since the relative amounts of steel and concrete in the most 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 $M = W \times l \times l / 8$ formula
3. Assuming the section to be balanced, find the depth of the beam.
 $M = Q \times b \times d \times d$
4. Find the area of steel $A_{st} = M / st \times jd$
5. Check for shear and spacing of stirrups is calculated
6. Check for End Anchorage
7. Check for deflection

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that this is crucial for ensuring transparency and accountability in the organization's operations.

2. The second part of the document outlines the various methods and tools used to collect and analyze data. It highlights the need for consistent data collection procedures and the use of advanced analytical techniques to derive meaningful insights from the data.

3. The third part of the document focuses on the implementation of data-driven decision-making processes. It provides a detailed overview of the steps involved in identifying key performance indicators, setting targets, and monitoring progress to ensure that the organization is on track to achieve its strategic objectives.

4. The fourth part of the document discusses the challenges and risks associated with data management and analysis. It addresses issues such as data quality, security, and privacy, and offers practical solutions to mitigate these risks and ensure the integrity of the data.

5. The fifth part of the document provides a comprehensive overview of the data ecosystem, including the roles of various stakeholders and the integration of data from different sources. It emphasizes the importance of collaboration and communication in ensuring that data is effectively shared and utilized across the organization.

6. The sixth part of the document discusses the future of data management and analysis, highlighting emerging trends and technologies that will shape the data landscape. It explores the potential of artificial intelligence, machine learning, and big data to revolutionize the way organizations collect, analyze, and use data.

7. The seventh part of the document provides a detailed overview of the data governance framework, including the roles and responsibilities of the data governance committee and the various policies and procedures that govern data management and use.

8. The eighth part of the document discusses the importance of data literacy and skills development for the workforce. It emphasizes the need for ongoing training and education to ensure that employees have the necessary skills to effectively work with data and make data-driven decisions.

9. The ninth part of the document provides a detailed overview of the data security and privacy measures implemented by the organization. It highlights the various security protocols, access controls, and privacy policies that are in place to protect sensitive data and ensure compliance with relevant regulations.

10. The tenth part of the document provides a final summary of the key findings and recommendations of the report. It emphasizes the need for continued investment in data management and analysis capabilities to ensure the organization's long-term success and competitive advantage.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes the need for transparency and accountability in financial reporting.

2. The second part of the document outlines the various methods and techniques used to collect and analyze data. It includes a detailed description of the experimental procedures and the tools used for data collection.

3. The third part of the document presents the results of the study, including a comparison of the different methods and techniques used. It discusses the strengths and weaknesses of each method and provides a detailed analysis of the data collected.

4. The fourth part of the document discusses the implications of the findings and provides recommendations for future research. It also includes a conclusion and a list of references.

The value of f_{ck} : 15
Enter the value of span l 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 a_{st} 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 T_c by referring the code book: 0.4
 t_v and t_c : 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 $l_y/l_x < 2$, two way slab is designed

If $l_y/l_x > 2$, One way slab is designed.

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

DESIGN PROCEDURE

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

$$M_u = 0.136 \times f_{ck} \times B \times d \times d.$$

Where M_u - factored bending moment

b - Breadth of slab

d - Effective depth of slab

f_{ck} - 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.

Faint, illegible text at the top of the page, possibly a header or title.

Second block of faint, illegible text, appearing as a paragraph.

Third block of faint, illegible text, appearing as a paragraph.

Fourth block of faint, illegible text, appearing as a paragraph.

Fifth block of faint, illegible text, appearing as a paragraph.

Sixth block of faint, illegible text, appearing as a paragraph.

Seventh block of faint, illegible text, appearing as a paragraph.

Eighth block of faint, illegible text, appearing as a paragraph.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in financial matters. This section also touches upon the legal implications of failing to maintain such records, which can lead to severe consequences for individuals and organizations alike.

2. The second part of the document delves into the specific requirements for record-keeping, including the types of documents that must be retained and the duration for which they should be kept. It provides a detailed overview of the various categories of records, such as financial statements, contracts, and correspondence, and outlines the best practices for organizing and storing these documents to ensure they are easily accessible and secure.

3. The third part of the document addresses the challenges associated with record-keeping, particularly in the context of digital information. It discusses the risks of data loss, corruption, and unauthorized access, and offers strategies to mitigate these risks. This includes the use of secure storage solutions, regular backups, and the implementation of robust access controls to protect sensitive information.

4. The fourth part of the document focuses on the role of record-keeping in legal proceedings. It explains how well-maintained records can serve as crucial evidence in court cases, helping to establish the facts of a matter and support a party's claims or defenses. It also highlights the importance of preserving records in their original form or as certified copies to ensure their admissibility in legal proceedings.

5. The fifth and final part of the document provides a summary of the key points discussed and offers practical advice for implementing a comprehensive record-keeping system. It encourages individuals and organizations to take a proactive approach to record-keeping, recognizing its value as a tool for risk management and operational efficiency. The document concludes by emphasizing that consistent and accurate record-keeping is not just a legal obligation, but a fundamental aspect of good business practice.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions and activities. It emphasizes that proper record-keeping is essential for transparency and accountability, particularly in the context of public administration and financial management. The text notes that without reliable records, it is difficult to track the flow of funds and ensure that resources are being used as intended.

2. The second part of the document addresses the challenges associated with data collection and analysis. It highlights that gathering accurate and timely data can be a complex task, especially when dealing with large-scale operations or multiple stakeholders. The document suggests that investing in robust data management systems and training personnel in data analysis techniques can significantly improve the quality and reliability of the information used for decision-making.

3. The third part of the document focuses on the role of technology in modernizing administrative processes. It argues that the adoption of digital tools and platforms can streamline workflows, reduce errors, and enhance the efficiency of service delivery. However, it also cautions that the successful implementation of technology requires careful planning, including the selection of appropriate software, the integration of existing systems, and the provision of adequate training and support for users.

4. The fourth part of the document discusses the importance of fostering a culture of continuous improvement and innovation. It suggests that organizations should encourage employees to identify areas for improvement and propose creative solutions to existing problems. Regular communication and collaboration between different departments are also emphasized as key factors in driving innovation and achieving organizational goals.

5. The fifth part of the document concludes by summarizing the key findings and recommendations. It reiterates the need for strong record-keeping, effective data management, the strategic use of technology, and a commitment to ongoing improvement. The document ends with a call to action, urging all stakeholders to work together to address the challenges identified and implement the proposed solutions.

Enter the value of f_y : 415
Enter the value of m_f : 0
Enter the value of w_p in KN/m : 3.125
Enter the value of finish w_f in KN/m : 1
Enter the value of liveload in KN/m : 3.0
Enter the value of centre to centre span l : 3.00
Enter the value of centre to centre span l_x : 3.07
Enter the value of centre to centre span l_y : 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 $P_u/F_{ck} bD$ ratio are calculated and design charts are referred M_{ux} , M_{uy} which are uniaxial moment capacities are calculated.

where d' = clear cover

D = depth of beam

P_u = axial load

5. Then P_u/P_{uz} and safe value of M_{uy}/M_{uy}' for corresponding M_{ux}/M_{ux}' value are calculated.

6. The safe value of M_{uy}/M_{uy}' is compared with actual value and it should always be greater than 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

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

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

Footings 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 $q_o = w/\text{Area of footing provided}$.

5. Calculate Moment capacity

$$M_{xx} = q_o/24[(2L+a) ((B-b)^2)].$$

$$M_{yy} = q_o/24[(2B+b) ((L-a)^2)].$$

6. Calculate depth and Area of steel.

7. Check for shear.

8. If $T_c < T_v < 1.5 T_c$ provide shear reinforcement

$$T_c = 0.16 (F_{ck})^{1/2} \text{ N/mm}^2.$$

here a = larger dimension of column.

b = smaller dimension of column.

l = larger dimension of footing.

B = Breadth of footing.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the integrity of the financial system and for the ability to detect and prevent fraud. The text notes that without reliable records, it would be difficult to track the flow of funds and identify any irregularities.

2. The second part of the document outlines the specific procedures for recording transactions. It details the steps involved in the accounting process, from the initial recording of a transaction to the final reconciliation of accounts. The text stresses the need for consistency and accuracy in these procedures to ensure that the financial statements are a true and fair representation of the organization's financial position.

3. The third part of the document addresses the role of internal controls in the financial reporting process. It explains how internal controls are designed to minimize the risk of errors and fraud, and to ensure that the financial statements are prepared in accordance with the applicable accounting standards. The text highlights the importance of a strong internal control system for the reliability of financial information.

4. The fourth part of the document discusses the impact of the financial reporting process on the organization's overall performance. It notes that accurate financial information is crucial for management decision-making and for the organization's ability to attract investment. The text also mentions the importance of transparency and accountability in financial reporting, and how these factors can contribute to the organization's long-term success.

5. The final part of the document provides a summary of the key points discussed and offers some concluding thoughts on the importance of the financial reporting process. It reiterates the need for a robust system of internal controls and accurate record-keeping, and encourages the organization to continuously improve its financial reporting practices to meet the challenges of the future.

6. The document also includes a section on the importance of communication in the financial reporting process. It explains that clear and concise communication is essential for ensuring that all stakeholders have a good understanding of the organization's financial performance. The text suggests that regular communication and reporting can help to build trust and confidence among investors and other interested parties.

7. In addition, the document discusses the role of technology in the financial reporting process. It notes that the use of modern accounting software and data analysis tools can significantly improve the efficiency and accuracy of financial reporting. The text encourages the organization to invest in technology to stay up-to-date with the latest developments in the field.

8. The document also touches on the importance of ethical considerations in financial reporting. It emphasizes that financial reporting should be conducted in a fair and unbiased manner, and that all transactions should be recorded accurately and honestly. The text suggests that a strong ethical culture is essential for the integrity of the financial reporting process.

9. Finally, the document provides a list of resources and references for further information on the financial reporting process. It includes links to relevant accounting standards, regulatory requirements, and industry best practices. The text also offers some advice on how to find and evaluate reliable sources of information.

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. This is essential for ensuring the integrity of the financial statements and for providing a clear audit trail. The records should be kept up-to-date and should be easily accessible to all relevant parties.

2. The second part of the document outlines the various methods used to collect and analyze data. These methods include interviews, surveys, and focus groups. Each method has its own strengths and weaknesses, and it is important to choose the most appropriate method for the specific research objectives.

3. The third part of the document describes the process of data analysis. This involves identifying patterns and trends in the data, and then interpreting these findings in the context of the research objectives. It is important to be objective and unbiased in this process, and to avoid drawing conclusions that are not supported by the data.

4. The fourth part of the document discusses the importance of communication in research. This involves sharing the findings of the research with the relevant stakeholders, and ensuring that the information is presented in a clear and concise manner. It is also important to be open to feedback and to be willing to revise the findings if necessary.

5. The fifth part of the document discusses the importance of ethics in research. This involves ensuring that the research is conducted in a way that is respectful of the rights and dignity of all individuals. It is important to obtain informed consent from all participants, and to ensure that the data is kept confidential and secure.

6. The sixth part of the document discusses the importance of transparency in research. This involves making the research process and findings as open and accessible as possible. This includes publishing the research findings in a peer-reviewed journal, and making the data and code used in the analysis available to other researchers.

7. The seventh part of the document discusses the importance of collaboration in research. This involves working closely with other researchers and stakeholders throughout the research process. This can help to ensure that the research is relevant and useful, and can also help to ensure that the findings are disseminated widely.

8. The eighth part of the document discusses the importance of reflection in research. This involves taking time to think about the research process and findings, and to consider the implications of the research. This can help to ensure that the research is meaningful and that the findings are used to inform practice.

9. The ninth part of the document discusses the importance of ongoing evaluation in research. This involves regularly assessing the progress of the research, and making adjustments as needed. This can help to ensure that the research is completed on time and within budget, and that the findings are of high quality.

10. The tenth part of the document discusses the importance of dissemination in research. This involves sharing the findings of the research with the relevant stakeholders, and ensuring that the information is presented in a clear and concise manner. It is also important to be open to feedback and to be willing to revise the findings if necessary.

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12. The twelfth part of the document discusses the importance of communication in research. This involves sharing the findings of the research with the relevant stakeholders, and ensuring that the information is presented in a clear and concise manner. It is also important to be open to feedback and to be willing to revise the findings if necessary.

13. The thirteenth part of the document discusses the importance of ethics in research. This involves ensuring that the research is conducted in a way that is respectful of the rights and dignity of all individuals. It is important to obtain informed consent from all participants, and to ensure that the data is kept confidential and secure.

14. The fourteenth part of the document discusses the importance of transparency in research. This involves making the research process and findings as open and accessible as possible. This includes publishing the research findings in a peer-reviewed journal, and making the data and code used in the analysis available to other researchers.

15. The fifteenth part of the document discusses the importance of collaboration in research. This involves working closely with other researchers and stakeholders throughout the research process. This can help to ensure that the research is relevant and useful, and can also help to ensure that the findings are disseminated widely.

16. The sixteenth part of the document discusses the importance of reflection in research. This involves taking time to think about the research process and findings, and to consider the implications of the research. This can help to ensure that the research is meaningful and that the findings are used to inform practice.

17. The seventeenth part of the document discusses the importance of ongoing evaluation in research. This involves regularly assessing the progress of the research, and making adjustments as needed. This can help to ensure that the research is completed on time and within budget, and that the findings are of high quality.

18. The eighteenth part of the document discusses the importance of dissemination in research. This involves sharing the findings of the research with the relevant stakeholders, and ensuring that the information is presented in a clear and concise manner. It is also important to be open to feedback and to be willing to revise the findings if necessary.

19. The nineteenth part of the document discusses the importance of documentation in research. This involves keeping a detailed record of all research activities, including the data collection process, the analysis process, and the dissemination process. This can help to ensure that the research is reproducible and that the findings are reliable.

20. The twentieth part of the document discusses the importance of communication in research. This involves sharing the findings of the research with the relevant stakeholders, and ensuring that the information is presented in a clear and concise manner. It is also important to be open to feedback and to be willing to revise the findings if necessary.

21. The twenty-first part of the document discusses the importance of ethics in research. This involves ensuring that the research is conducted in a way that is respectful of the rights and dignity of all individuals. It is important to obtain informed consent from all participants, and to ensure that the data is kept confidential and secure.

22. The twenty-second part of the document discusses the importance of transparency in research. This involves making the research process and findings as open and accessible as possible. This includes publishing the research findings in a peer-reviewed journal, and making the data and code used in the analysis available to other researchers.

23. The twenty-third part of the document discusses the importance of collaboration in research. This involves working closely with other researchers and stakeholders throughout the research process. This can help to ensure that the research is relevant and useful, and can also help to ensure that the findings are disseminated widely.

24. The twenty-fourth part of the document discusses the importance of reflection in research. This involves taking time to think about the research process and findings, and to consider the implications of the research. This can help to ensure that the research is meaningful and that the findings are used to inform practice.

25. The twenty-fifth part of the document discusses the importance of ongoing evaluation in research. This involves regularly assessing the progress of the research, and making adjustments as needed. This can help to ensure that the research is completed on time and within budget, and that the findings are of high quality.

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 f_{ck}	: 15
Enter the value of f_y	: 415
Enter the value of tread t_r in mm	: 300
Enter the value of rise r_i in mm	: 150
Enter the value of landing width L_w in mm	: 5000
Enter the value of modification factor m_f	: 1.1
Enter the value of live load L.L in KN/m	: 1
Enter the value of floor height f_h in metres	: 3
Enter the value of floor finish f_f in KN/m	: 1
Enter the value of width of stair w_d in metres	: 1.5
Please enter the value of t_c 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 reinforcement with 15 mm cover	
Overall depth is 493 mm	
The value of μ_u	: 917.844116 KN/m
10 mm Dia Bars are used	
The value of a_{st} is 5768.981445 Sq.mm	
Number of bars	: 74
Distribution steel value 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 t_c 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%

REFERENCES

1. REINFORCED CONCRETE STRUCTURES - *I.C. Syal & A.K. Goel*
2. CONCRETE STRUCTURES - *V.N. Vazirani & M.M. Ratwani*
3. LIMIT STATE METHOD OF DESIGN - *Jain*
4. BUILDING DRAWING - *M.G. Shah, S.R. Patki & C.M. Kale*
5. STRUCTURAL ANALYSIS - *P.S. Pandit & S.P. Gupta*
6. A GUIDE TO SITE ENVIRONMENTAL PLANNING - *H. Reben Stein*
7. FLEXIBILITY OF BUILDING FOR EDUCATION - EDUCATIONAL BUILDING REPORT.
8. ANONYMOUS: IS-456-1978 CODE OF PRACTICE FOR PLAIN AND REINFORCED CONCRETE
9. DESIGN 'SP:16' AIDS FOR REINFORCED CONCRETE
10. CIVIL ENGINEERING - A CONSTRUCTION REVIEW, NOV. 1996.
11. A NOTE ON HOW TO REDUCE STEEL CONSUMPTION IN REINFORCEMENT CONCRETE BUILDINGS. CONSULTING STRUCTURAL ENGINEER, NEW DELHI. *U.H. Varyani.*