COMPARATIVE STUDY OF EXTERNAL SERVICES IN HORIZONTAL v/s VERTICAL DEVELOPMENT OF UNIVERSITY CAMPUSES

A DISSERTATION
submitted in partial fulfilment of the
requirements for the award of the degree
of
MASTER OF ARCHITECTURE

By

S. S. UTGIKAR

UNIVERSITY OF ROORKEE CENTRAL
107529
14/5/73

DEPARTMENT OF ARCHITECTURE
UNIVERSITY OF ROORKEE
ROORKEE (INDIA)
October, 1972

C E R T I F I C A T E

Certified that the dissertation entitled 'COMPARATIVE STUDY OF EXTERNAL SERVICES IN HORIZONTAL V/S VERTICAL DEVELOPMENT OF UNIVERSITY CAMPUSES' which is being submitted by Shri S.S. Utgikar in partial fulfilment for the award of the degree of MASTER OF ARCHITECTURE Department of Architecture, University of Roorkee, Roorkee, India, is a record of the student's own work carried by him under my supervision and guidance. The matter embodied in this dissertation has not been submitted for the award of any other degree or diploma.

This is further to certify that he has worked for a period of 8 months from 1st January, 1972 to 31st August, 1972 for preparing this dissertation at this University.

A.J. Contractor

(A.J. Contractor)
Reader in Architecture
Department of Arch.
University of Roorkee,
Roorkee, India

ROORKEE
Dated: Oct. 3rd, 1972.

ACKNOWLEDGEMENT

The author wishes to express his sincere gratitude to Shri A.J. Contractor, Reader in Architecture, for his continued encouragement, keen interest and guidance during the preparation of this thesis.

The author takes this opportunity to express his sincere gratitude to Professor G.H. Mandalia, Head of the Architecture Department for his valuable guidance in shaping and moulding the work to this form.

The author is thankful to authorities of various Universities for the information supplied, without which this thesis could not have been completed.

Thanks are also due to all those who indirectly helped the author in the preparation of this thesis.

(S.S. Utgikar)

ROORKEE
Dated: 4th Oct. '72

C O N T E N T S

Page No.

I N T R O D U C T I O N

The concept of campus planning for educational institutions of higher learning is an accepted trend today. This concept was developed right from the 5th century A.D. when Nalanda Visvavidyalaya had a well planned campus. A lot of work has been done on the various aspects of campus planning but unfortunately the work concerning the external services in campuses has been neglected. Moreover a pressing need of vertical growth of campus mainly due to shortage of land has been realised. Vertical development is fast replacing the horizontal campuses in U.S.A. but India is having horizontal spread out campuses, exceptions apart. In the light of lateral and vertical systems the author had chosen to study the external services for campuses of both types.

In the preindependence period there were only twenty Universities in India. But this number increased rapidly after independance and at present we have eightysix Universities including specialised Universities and institutions deemed as Universities. Urge of people for higher education is increasing and hence either new Universities have to be established or old existing campuses have to be expanded. The U.G.C. favours opening

of new Universities. Cost of services plays a great role in the development of a campus it varies from Rs.7,000/- per acre to Rs.23,000/- per acre in existing campuses studied and hence these must be thoroughly studied.

Aim of the thesis is to study the external services which includes:

1) Circulation systems
2) Sewerage
3) Water supply
4) Electricity supply and
5) Telephone lines in a campus.

and the impact of horizontal and vertical planning on it.

Campus planning at first sight appears to be a sizable subject. But when taken in its all encampassing parameters it turns out to be a subject of great magnitude. Hence, it is necessary to study it in certain restricted areas. For the purpose of this thesis two main restrictions have been accepted:

1) External services only
2) In the academic zone only

Other aspects are not considered here mainly.

The author earnestly hopes that his studies will provide useful guide to the professional planners.

administrative planners and the academicians in their future proposals for campus planning in respect of external services, and more particularly for vertical campuses.

Part I Basic Study

CHAPTER I

CAMPUSES IN PAST

Introductory:

The study of history, is nothing but becoming aware of what existed in the past, of the transient phase that altered the mode and concept of education and the projection of past into the future via the created present.

De Carlo, Architect of University College -URBINO, states, 'What I consider as history is an acquisition of an exact knowledge of the problems we, as architects touch on; so that our solutions and our choices are tied to continuous reality and are progressive. History does not concern itself with the past, but with the present and gives direction to the future.

Before studying the University Campuses it is essential to know the meaning and definitions of University and of Campus.

1.1 Definitions:

a) University:

The word 'University' comes originally from Latin term 'Universitas' which means a community or a corporation. In modern sense it means a body devoted to learning and education. In 14th century the term began to be used by itself, with the exclusive meaning of a lawfully recognised community of teachers

and scholars.[1]

The University appears to have started as a scholastic guild similar to trade guilds. Their aim in the first instance was little more than that of securing mutual protection.

This old concept has now changed. We may define a University as an 'Organised and degree giving institution, intended for the study and advancement of the higher branches of learning, self governing in its nature, and to a greater or less extent national in its scope'.[2]

Indian terminology for University is 'Viswa Vidyalaya' which means a place of learning of Universal subjects in Arts and Science, comprising various college buildings, prayer halls, residences etc.[3]

b) Campus:

Campus is a Latin word meaning 'level plain'. Initially the name was given to a number of open spaces in and about the city by the Romans: of these the famous was the 'Campus Martius' a site of horse race.[4]

Americans used the word campus to describe their college grounds, a land owned by a college or University and used for

---

1. 'Encyclopaedia Britanica' Vol.21, page 862.
   Published by William Benton, (1962).
2. 'Universities in Transition' Past-Present-Future, page 5
   H.C. DENT
   Cohen and West Publication
3. 'MANSARA' Encyclopaedia of Hindu Architecture, page 465
   Vol. VII, By Dr. Acharya
   Published by Oxford University Press, Calcutta 1949.
4. 'Encyclopaedia Britanica' Vol.4, page 685.
   Published by William Benton (1962).

their purpose. The term gradually widened and was used in 20th century for other activities such as Athletics, Social, Dramatic and other extra curricular activities.

The contemporary technical concept of 'campus' is that of an 'Educational Campus'or an area meant specifically for academic purpose, on which is created the proper physical environment in the form of buildings for study and allied activities among natural landscaping.

'Campus Planning' is the process of designing and locating the buildings for above activities fulfilling present and future needs. Designing with respect to local planning considering community needs.

1.2 Education System in Ancient India:

'Gurukula', a single teacher institution is the begning of education system. The Gurukulas were the domestic schools whose expenses were met by the collection of alms by the pupils from door to door and from the gifts. A child had to go to Gurukula after thread ceremony at the age of six. There are few examples like Dronacharya where Guru goes to the students house.

Gurukulas were confined to upper three castes of Aryan society. The Gurukul was situated away from the city life and was housed in an engironment which was ideal for the purpose of education. According to ancient Guru horodity and envirnoment both were interdependent and necessary for higher

LOCATION OF
ANCIENT UNIVERSITIES

education.[5]

The regulations regarding the relation between the teachers and the taught were first compiled in 'Brahma Sutra' which dates back to 500 B.C.

From his Guru the student passed at about the age of sixteen and then joined one of the great Universities that were glory of ancient India. Some of these Universities are Nalanda, Taksha Sila, Ajantha, Banaras, Vikramsila, Kanchi, Odantapuri and Vallabhi (see plate No.1). Some of these are considered here under:

Campus planning for educational institutions in India is at least as old as 5th century A.D. when Nalanda 'Vishva Vidyalaya' was founded. Students from Asia came here for learning. Some Universities were famous for specialised knowledge given for example Ujjain for Astronomy.

1.3 Nalanda Viswa-Vidyalaya:

Excavated in 1915-16 by General Cunningham, Archeological Survey of India.

Location:

It was located 40 miles South West of PATNA in BIHAR (7 miles from Rajagriha).

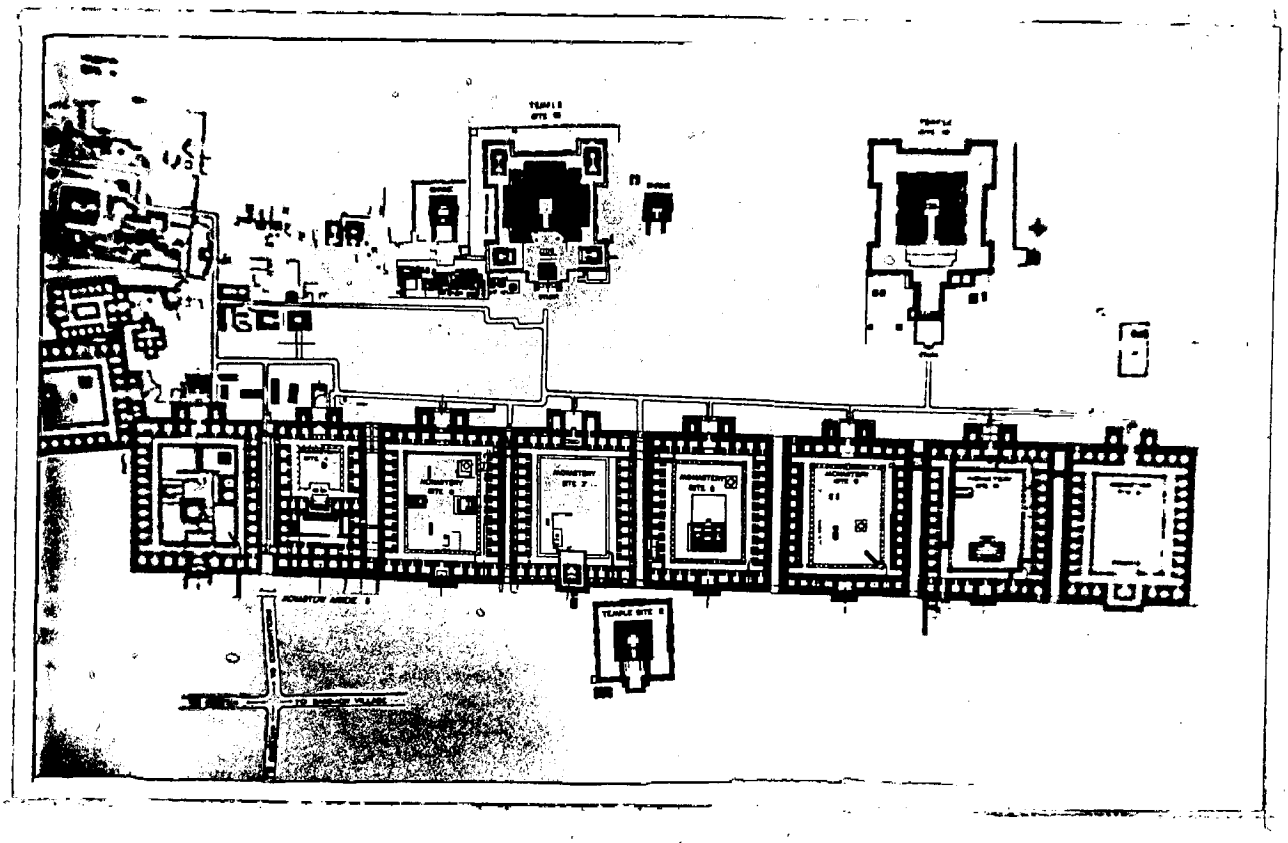
Monastery at Nalanda was built by Kumar Gupta I (450 A.D.).[6] According to some historians it is Chandra Gupta II

---

5. 'Ancient India' Culture and thought, page 61
M.L. Dhagi
The Indian Publication, Ambala Cantt. (1965)

6.' Bihar Through the Ages' page 291, R.R. Diwakar
Orient Longmans Publication.

PLATE NO 2



NALANDA-VISVAVIDYALAYA

LINEAR AND COMPACT PLANNING

i.e. Devaraja (500 A.D.). Last head of Nalanda University was Silabhadra. Towards the end of 12th century Nalanda was destroyed by Bakhtiar Khilji.

Site:

The site of Nalanda measures 1 mile x ½ mile.[6] Main parts of the campus were

a) Group of Stupas

b) Temple of Shrine

c) Residences for Monks

d) Various Colleges

e) Hostels for students

f) Open spaces

The whole establishment was surrounded by brick wall which encloses the entire campus from out side. One gate opens in to the great college from which other colleges are separated.

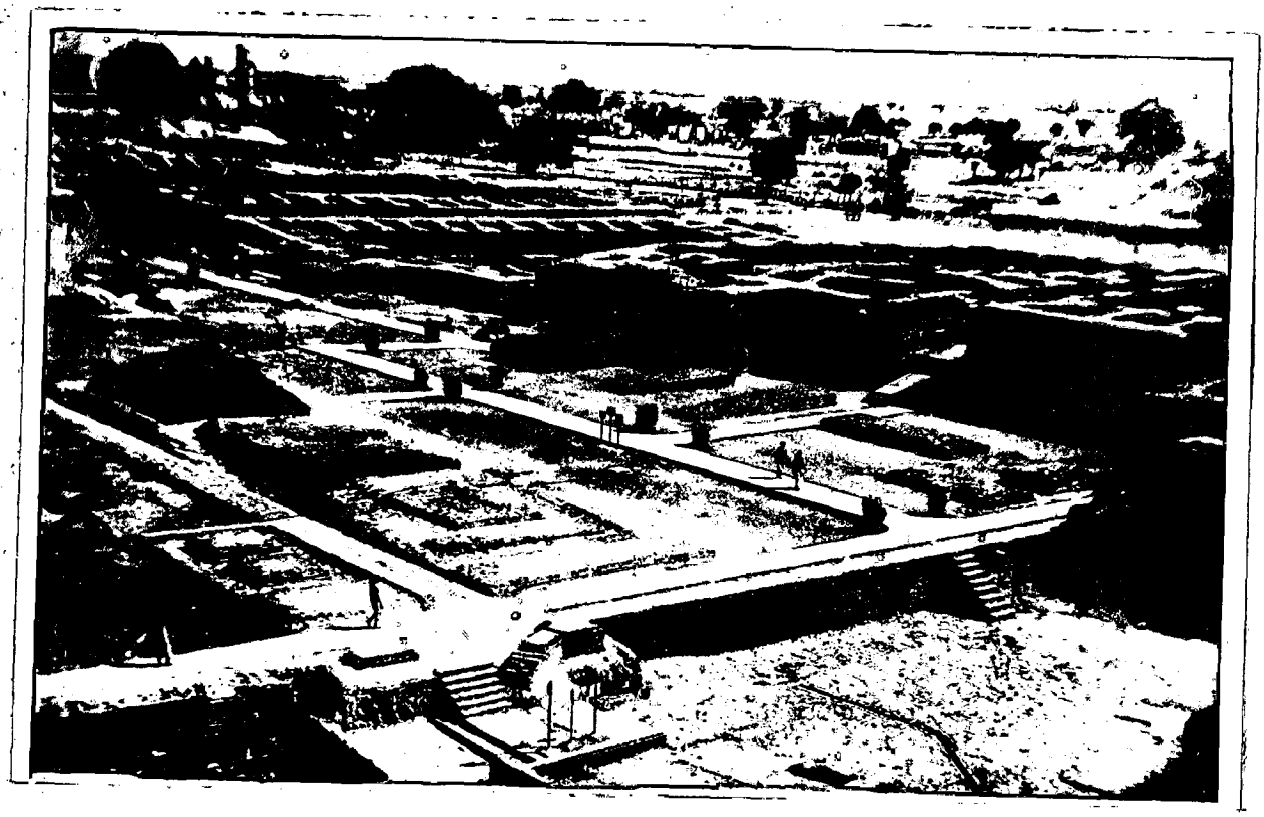
Academic:

Duration of the course was 12 years. It had 10,000 students and 1510 teachers. University had 300 buildings, 8 big halls and 300 class rooms in Sanghrama which was the main building.[7] Every day 100 lectures were given in this building. This covered studies of Vedas, Logic, Grammer, Philosophy, Medicine, Law, Astronomy and Technology. There was no cast

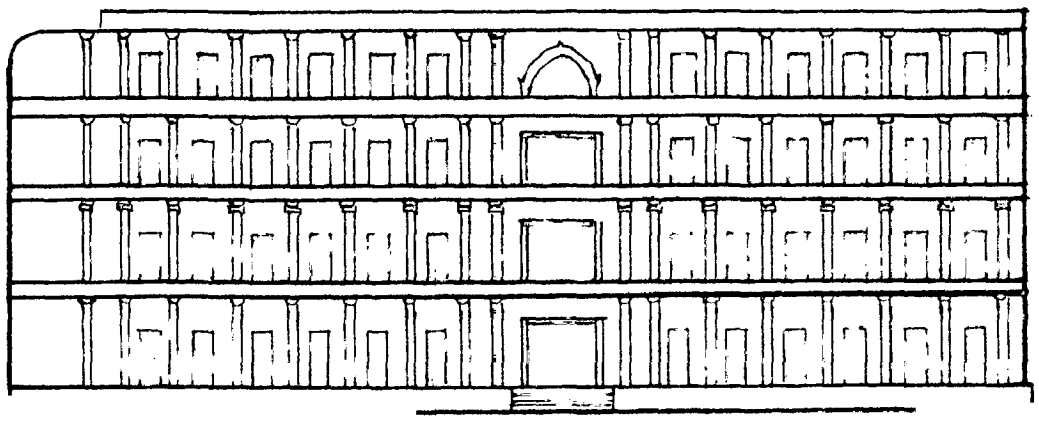
---

7. 'The Story of Civilisation' Our Oriental Heritage, page 557-58
Vol.1 Will Durant
Simon and Schuster, New York (1954).

PLATE No 3



NALANDA UNIVERSITY



ELE. OF VIHARA

SCALE 20 0

restriction, even Indian and foreigners mixed together. It was a residential University. Admission was very strict. Students were examined on the gate, only 2-3 out of 10 could get admission in University.

Campus Planning:

The excavations show that the city had a planned layout with rows of monasteries, Hostels leaving a wide space in between. Development was linear (see plate No.2).

It had 8 lecture halls in the middle of Sanghrma. Its observatories, said 'Yuan Chwang', were lost in the vapours of the morning and the upper rooms of towers above the cloud.

According to Tibetan accounts Nalanda was equipped with a huge library in three tall buildings. This was known as Dharmaganja (Mart of Piety). Three buildings were named as Ratnadadhi (Sea of jewels) which was nine storied in height. Second one called 'Ratna Sagara' (ocean of jewels) and third 'Ratna Raja' or 'Ratna-Ranjaka' (Jewel adorned).[8] The flowing stream near by added to the beauty of campus and kept it cool.

Students Residences:

It was a residential University and students were given free tution, boarding and lodging. There were six imposing blocks of hostels, 4 storied high (see plate No.3).

---

8. 'Ancient India'Culture and thought, page 61.
M.L. Bhagi
The Indian Publication, Ambala Cantt. (1965).

The monastries or Viharas were placed adjacent to each other i.e. linear development. The plan of individual vihar as is nearly identical in the structures excavated and consists of many small cells grouped arround the four sides of an open court yard. All rooms open out to a court yard which is connected to the movement channel (paths), through a very small door way. These paths connected different monastries.

It was constructed with thick walls of bricks and stones. The outside of it was not plastered: while stone walls were well polished.

The financer of this University were Guptas, Harsa, Pala and King of Sumatra. It was a land-grant University and had 200 villages given as gifts for its running expenses.[9]

Services and Utilities:

Banks and wells were the usual sources of water supply. As the soil of Nalanda was soft and water table sufficiently high tanks and wells could easily be dug out. Every morning student had to bathe in swimming pool that belonged to the University.

Open drains constructed of bricks were also used as sewer lines. These drains were pierced through solid walls and the waste was discharged out side the monastery, in the central court yard. The kitchens were located in the central

---

9. 'Ancient India', History and Culture, page 144
B.G. Gokhale
Asia Publication house Bombay, (1959).

court yard so that food could be easily served. The well was also placed close by, generally in the north west corner of the monastery.

Nalanda was burned to ground in 1197 A.D. and its monks were slaughtered by Bakhtiar Khilji.

1.4. Taksha-Sila (Taxila):

7th to 3rd Century B.C.

Excavated by John Marshall, Director general of Archaeology in India 1863 to 79.

Location:

It is located 20 miles North west of Modern Rawalpindi (Pakistan).

In the excavation, two cities have been discovered on the sides of a broad main street. The first city is known as 'Bhir-Mound' and the second as 'Sirkap'. Arrian describe it as 'A large and prosperous city'.

Taksha Sila suffered constantly from political upheavals. In 6th century B.C. the 'Brahmi' script was changed to 'Kharosti' by Persians.[10]

Academic:

Taksha-Sila was known to all Asia as the leading seat of Hindu Vidyalaya. It was renounced for its medical school.

---

10. 'Ancient India' Culture and thought, page 70
M.L. Bhagi
The Indian Publication, Ambala Cantt. (1965).

The Jatakas refers to as many as 500 students including 100 princes[11] who used to study various subjects at Takshashila. Teaching was mainly in the hands of Brahmins, Sixty Eight different arts were taught.

Teachers accepted at least 20 students at a time to guide them. The student paid fees at the commencement of the course or at the end. The fees were 500 or 1000 Kahapanas accordingl to the financial position.[12] The poor had to give his services to teachers for the day and had to learn in night. They were called as 'Dhammanto Vasika' as against those fee payers 'Acariyabhagadayaka'.[13] Free education for few poor students by some charitable community was also provided.

Campus Planning:

It had no great halls or lecture rooms. No campus and no laid down conditions of admission. It was University only in the sense of being a seat of advanced learning. References suggest that teachers houses were used as a seat of learning. The archaeologists have not found any site which could be the

---

11. 'The story of Early Indian Civilisation' page 57, 60 C.E. Sen
Oriental Longmans Bombay (1964).

12. 'Ancient India' History and Culture, page B.G. Gokhale
Asia Publication House (1959).

13. 'Pre-Buddhist India' page 300 R.N. Mehta
Eranina Press, Bombay (1939).

campus of this ancient seat of learning. This also confirms that only teachers residences were used as places of learning. Day scholars were also permitted. Prince Junha of Benaras had an independent house for himself from which he attended the college.[13] Married men also had their own houses.

Planning of monasteries was simple, a central court yaard with cells sorrounding, (See plate No.5). The walls constructed were of 'Diaper Pebble'[15] type i.e. wall consisted of embadding pebbles in a mass of mud mortor. The reinforcement of the walls was done by insertion at regular intervals of irregular blocks of Stone.

The mechanism of planning the various departments and integrating them in to a cohesive and continuous pattern in Punjab University Campus, Lahore is analogous to the plan of ancient Taksha-Sila.[14] (See plate No.4).

Services:

The first city known as 'Bhir Mound' had irregular, crooked main street and narrow lanes. The second city 'Sirkap' had a fine main street 20' wide running North-South with narrow roads[16] running perpendicular to it at regular

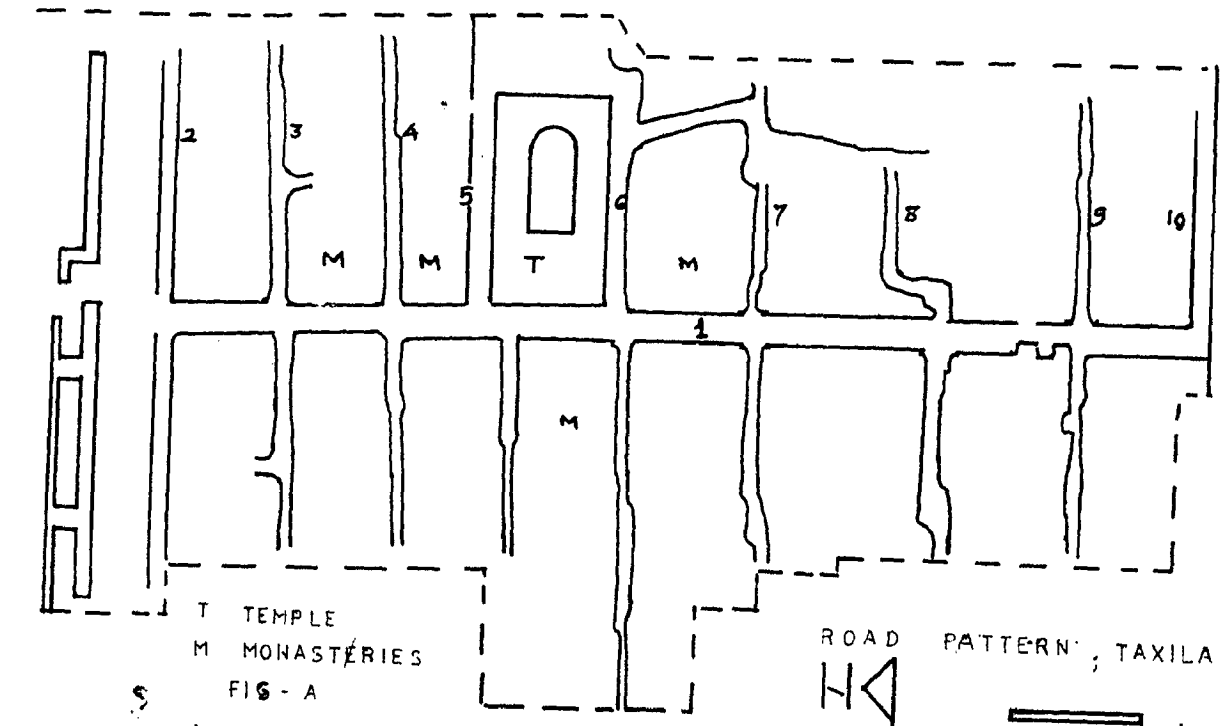
---

14. Punjab University Campus: Lahore, page 196
Doxiodis
Ekistics Vol.15-16 September (1963).

15. 'Indian Architecture' Buddhist and Hindu Period, page 155
5th edition. Percy Brown.
Taraporwal Sons and Co.Pvt. Ltd., Bombay (1965).

16. 'The Wonder that was India' page 164-65.
A.L. Bashams
Sidgwick and Jackson, London (1964).

PLATE No. 4



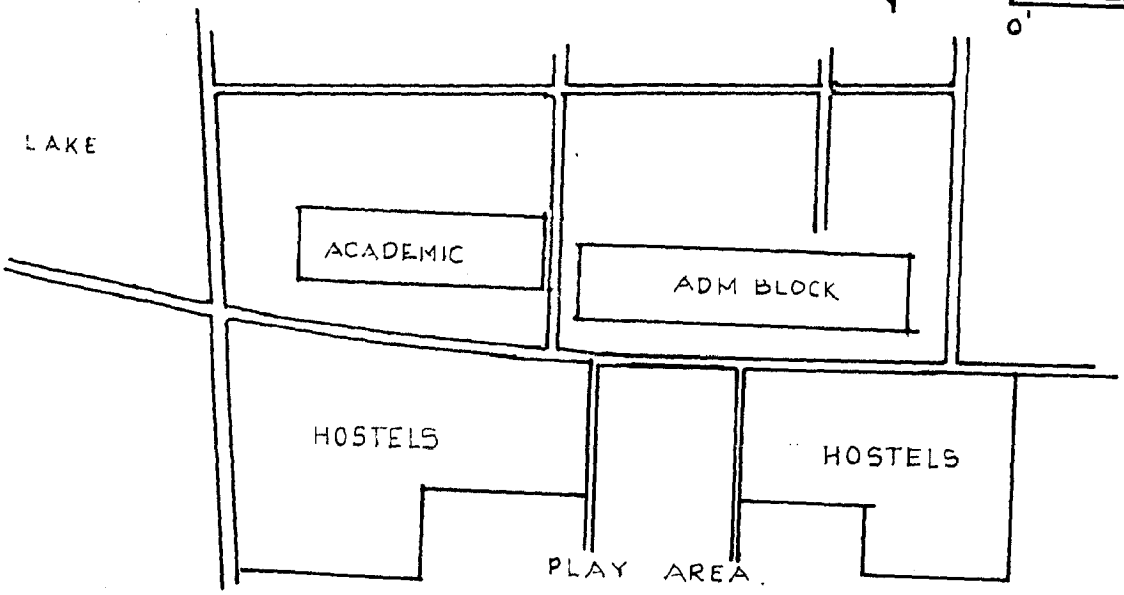


FIG-13 PUNJAB UNIVERSITY, LAHORE . TAXILA

Fig.B 'Punjab University Campus, Lahore page 196
FKISTICS
Sept. 1962

intervals. (See plate No.4 Fig.A). It was a well planned city.

Water distribution was from canal and was controlled. Roads were planted with trees. Anyone found damaging the road or obstructing the traffic flow was fined.

The first of the Bactrian invaders to Taksha-sila was Demetrius Son-in-low of Antiochus the great (190 B.C.). The destruction is mainly by white-Huns(455 A.D.).

1.5 Other reputed Universities in Ancient Period:

Other than these two famous Universities, some reputed Universities were as follows. Unfortunately sufficient information is not available about their Campuses.

a) Kanchi: Mid 7th century A.D.

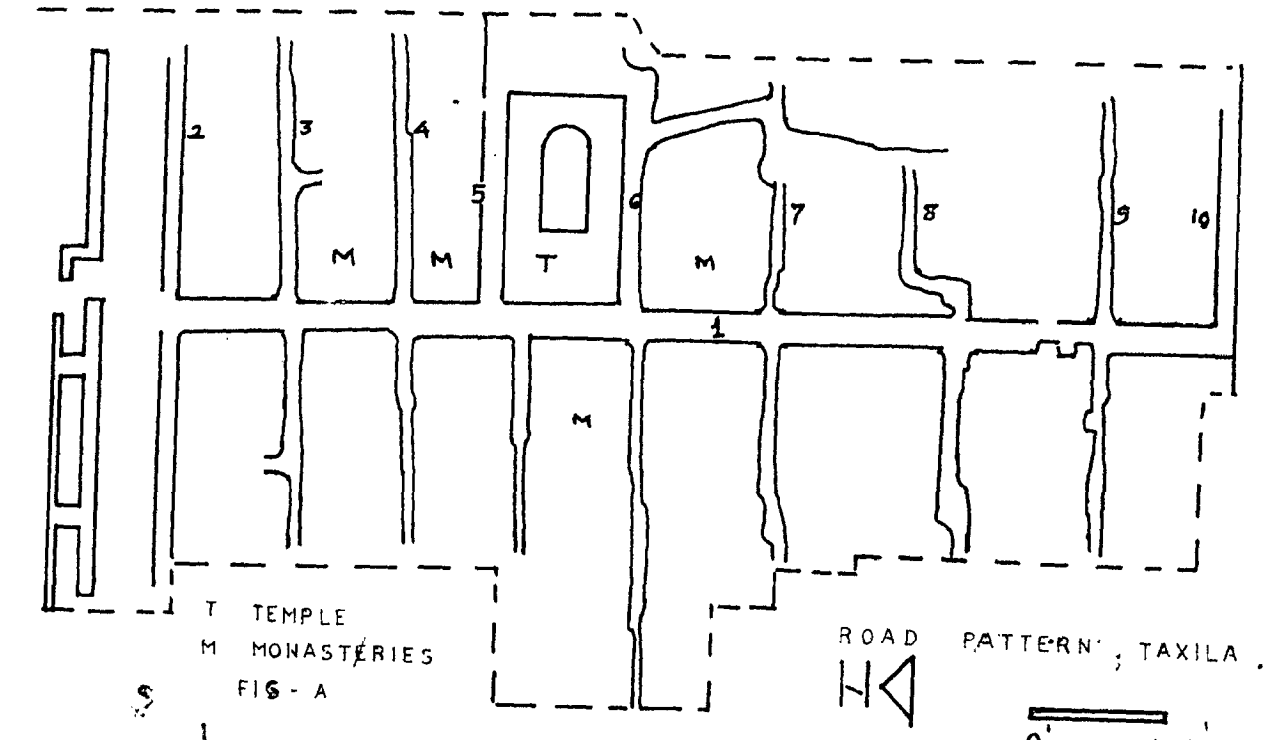
Now known as conjee Varam in Chingaleput Distt. Madras.

It was a Pallava Capital in South India. Teaching of Buddhist scriptures was a special feature of Kanchi. Kautilya is said to have spent his educational career here. Hiuen-Tsang described that at least 1000 priest lived in 100 Sangharamas.[17] It had eight buildings for learning. The city was famous for its Architects. Narsimha Verman son of Mahendra Varman I of Pallava dynesty was the Architect of Kailashnath Shrine at Kanchi and shore temple at Mahabalipuram.

---

17. 'Ancient'India' Culture and thaught, page 65
M.L. Bhagi
The Indian Publication, Ambala Cantt. (1965).

PLATE No. 4



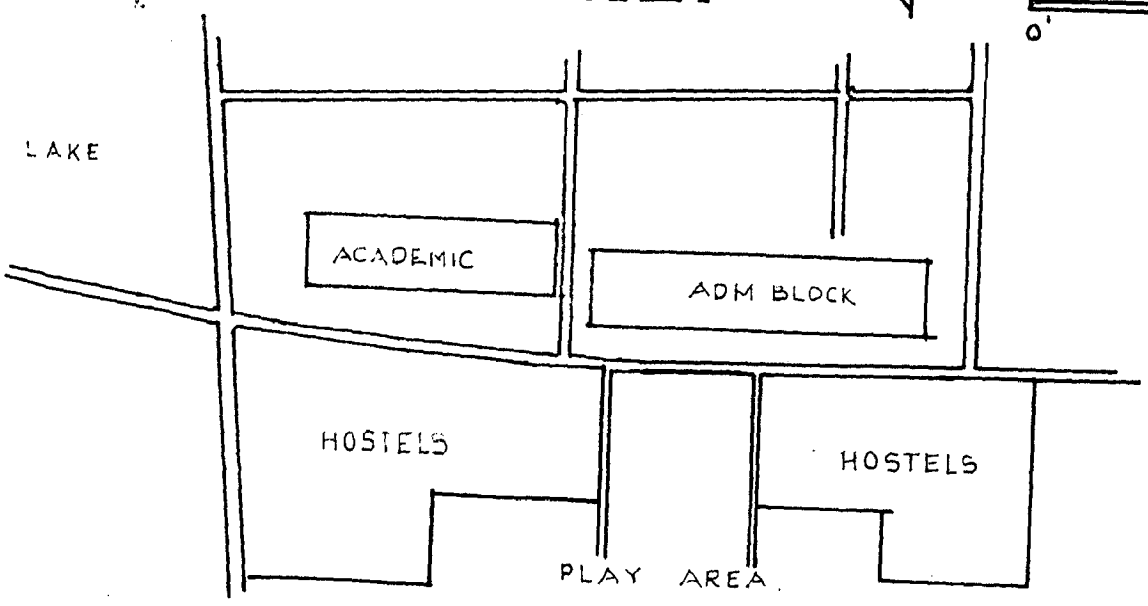
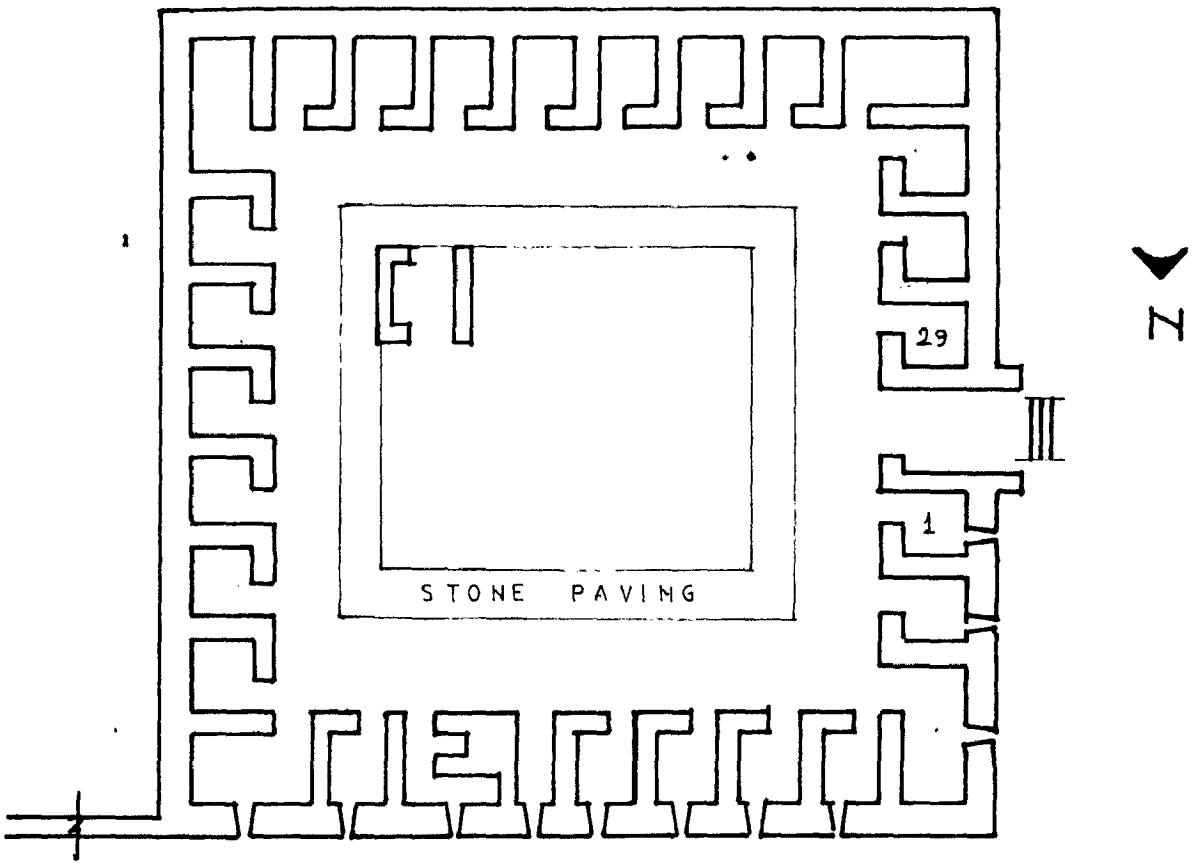


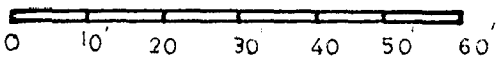
FIG-B PUNJAB UNIVERSITY, LAHORE.

TAXILA

Fig. B Punjab University Campus, Lahore page 109
EXISTING
Sept. 1983

PLATE No. 5





PLAN OF MONASTRIES AT TAXILA

UNIVERSITY AT TAXILA

intervals. (See plate No.4 Fig.A). It was a well planned city.

Water distribution was from canal and was controlled. Roads were planted with trees. Anyone found damaging the road or obstructing the traffic flow was fined.

The first of the Bactrian invaders to Takcha-sila was Demetrius Son-in-law of Antiochus the great (190 B.C.). The destruction is mainly by white-Huns(455 A.D.).

1.5 Other reputed Universities in Ancient Period:

Other than these two famous Universities, some reputed Universities were as follows. Unfortunately sufficient information is not available about their Campuses.

a) Kanchi: Mid 7th century A.D.

Now known as conjee Varam in Chingalaput Distt. Madras.

It was a Pallava Capital in South India. Teaching of Buddhist scriptures was a special feature of Kanchi. Kautilya is said to have spent his educational career here. Hiuen-Tsang described that at least 1000 priest lived in 100 Sangharamas.[17] It had eight buildings for learning. The city was famous for its Architects. Narsimha Varman son of Mahendra Varman I of Pallava dynasty was the Architect of Kailashnath Shrine at Kanchi and shore temple at Mahabalipuram.

---

17. 'Ancient'India' Culture and thought, page 65
M.L. Bhagi
The Indian Publication, Ambala Cantt. (1965).

b) Vallabhi:

It was a capital of the Maitrika King in Kathiawar during 475 A.D. to 775 A.D. Originally it was a commercial centre and later developed in to a place for learning under the patronage of royal family. Its reputation surpassed even Varanasi and Nalanda.

Hinayanism was the special subject of this University. It is said that Sthiramati and Gunmati of Nalanda fame joined this institution.

c) Vikrama Sila:

King Dharmapala laid the foundation stone of this University in 8th century A.D.

It is located in Bhagalpur District Bihar.

This survived as a great University for 4 centuries. It had a campus surrounded with stone walls with 6 gates leading to 6 different colleges. There were 114 teachers having specialization in different subjects. 3000 students were residing on campus.[18] Admission was strict. A learned professor was incharge of each gate who gave admission to students. Their names as mentioned by Dr. R.N. Mukerji are:

1) Ratnakara Kirti	East Gate
2) Vigisvara Kirti	West Gate
3) Naropa	North Gate

---

18. 'Cities of Ancient India' page 76
B.N. Puri
Meenakshi Prakashan, (1966).

4) Prajanakaramati South Gate

5) Ratna Vajra of Kashmir Central Gate

6) Jnanasrimitra of Gada Second Gate

It had more foreign students than Nalanda. Nalanda and Vikrama Sila were managed by a joint board with Dharma Pala as patron.

It was destroyed by Bhaktiyar Khilji.

d) Sanskrit College at Salotgi, District Bijapur:

Middle of 10th century A.D.

Founded by a minister of Krishna Raja II ruler of Rashtrakuta Dynasty in Bijapur District.

It had students hostels and a well planned campus. Local inhabitants used to contribute for the upkeep of the college. A desirable sum on the occasion of every marriage and thread ceremony was given to the college.

e) Temple College at Ennayiram: (11th century A.D.)

Location	South Arcot District of Madras
Site	300 Acres
Enrollment Number	340 students.

The Speciality of this University was[18] that seats were reserved for different subjects as follows.

---

18. 'The story of Early Indian Civilisation', page 187 G.E. Sen

75 seats for study of Rig-Veda

95 seats for study of Yajur Veda

20 seats for study of Up-nishada

25 seats for study of Grammer

35 seats for study of Mimamsa

10 seats for study of Vedanta

Teachers received their food plus annual gift of gold. Teacher of Vedanta received more than other. It was a land grant University.

1.6 Universities (Institutions of Higher Learning)under Muslim Rule:

Madarsahs: Institution of higher learning.

These were essentially schools of Theology with auxiliary linguistic studies and financed by the states with their strong hold.

Muslims being orthodox, the aim of education was to stabilize the religion. The out come was fit for the posts of Quazis, Muftis and other administrators. By middle of 13th century the science and culture of Islamic world was brought to India and Delhi became the greatest centre of Muslim learning. Iltumish of Delhi was the first to establish Madarsah at Delhi naming 'Madarsa-e-Muizzi'.[19]

Teaching was not confined to religion in the latter days. In the Madarsah of Delhi, founded by Humayun, mathematics

---

19. 'Glimpses of Medival Indian Culture' page 71 Yusuf Husain
Asian Publishing House (1962).

astronomy and geography were taught. Akbar added important subjects as arithmetic, mensuration, geometry, accountancy, public administration and agriculture. Science was much advanced, Mir Fathullah Shirazi had invented a gun whose parts could be separated while marching.

Akramuddin Khan (Aurangzeb period) of Gujrat built a Madrasah at Ahmedabad at an expense of Rupees One lac and twenty four thousand, village of Sabilah was given for its running expenses. Stipend of Rs.2.00 per day was given to deseriving students.[20] There were constant and intimate contacts between teacher and students. Teacher was totally responsible for the academic career of student.

Each seat of higher learning was specialized in one particular branch, for example Delhi school of Shah Watiullah specialized in the Traditions (Hadis), the Farangimathli schoo of Lucknow specialized in Jurisprudence (Figh) and the Sialkot school specialized in the grammer.

One who had a good knowledge in logic and philosophy was awarded the degree of 'Fazil', one who specialized in Theology was awarded a degree of 'Alim' and degree of 'Qubil' for specialization in literature.[21] A regular ceremony calle 'Rasm-i-dastrabandi' was held when these degrees were awarded to eligible students. There were special Madarsah for ladies.

20,21. 'Glimpses of Medival Indian Culture' page 87 and 92 Yusuf Husain
Asia Publishing House, (1962).

Some of the famous Madarsahs are as follows:

a) Jaunpur: (1398 A.D.)

A great centre of education under the rule of Sultan Ibrahim Shah (1402 to 36). It received the title of 'Shiraz-i-Hind' i.e. King of University Town.

The Madarsah of 'Bibi-Raja-Begam' was the most famous institution of Jaunpur. Theology, history and philosophy were main subjects of learning.

b) Bidari Founded in (1472 A.D.)

Mahmud Gavan, the Minster of Mohamad Shah III, a persian scholar, has established this institution and had a building similar to his own training institution in Persia.

Planning[22]

It had lecture halls, library, mosque rooms for teachers and students arround a rectangular open space. Building was three storied in height and measured 205'x180' Maulana Abdur Rahman Jami was the Principal in the regime of Mahmud Gavan.

c) Mandu (1436-1450)

Ancient capital of Hindu at Dhar was shifted to Mandu in 15th century by Ghuri dynasty.

Facing to Jama-Masjid there is a large complex known as the Ashrafi-Mahal (palace of gold mohur) in the regime of

---

22. 'Indian Architecture' Islamic Period, page 70 Percy Brown
Taraporvala and Sons, Bombay.

Mahmud (1436-69), each side of which is 320'.[23] It consists of three distinct structures. The first of these buildings was a Madarsah, one storey structure with halls and compartments arranged arround a large rectangular court yeard with a circular tower at each corner. College rooms had a roof of Pyramidal Vaults and a covered corridor in front.

In 1450 this structure was converted to imperial mausoleum.

1.7 European Universities in the Past:

First two centres of learning in Europe to take the shape of Universities were both in Italy[24] at Salerno and Bolwgna. Former was established in the middle of 9th century and was a school of medicine. Latter was a school of civil and cannon law and was opened in the year 1158 A.D. Third University came up about 1150 to 70 A.D. at Paris and was famous for its teachings at Philosophy and Theology. These Universities were under the control of Church and Chancellor was a cathedral Officer appointed by Bishop.

In the middle of 13th century the University college was started at Oxford. Aim was to give higher education to whom existing Universities were inaccessible. Initially it gave

---

23. 'Indian Architecture' Islamic Period page 62
Percy Brown
Taraporval and Sons, Bombay.

24. 'Encyclopaedia Britanica' page 862
Vol.21, Published by William Bantom (1962).

residential accomodation to teachers only but later on in 14th century students and staff lived together and tution was given inside the college. Buildings were small and much space was not needed.

Between 1500 to 1515 A.D. colleges were constructed having rooms for lecturers, library and common rooms for students. As late as 1564-67 a big hostel for about 70 students was built at Pavia.[25]

Concluding Remarks:

From the study of these University Centres, it is clear that Universities in ancient periods were much advanced in Campus planning particularly Nalanda Visva Vidyalaya. Though land was easily and economically available its planning was compact. Development was in linear direction with vertical buildings, even though mechanical vertical communication facilities such as lifts were not available.

Emphasis was also given on services and facilities for students. Hostels were provided. Roads were straight and not too wide. Maximum traffic was that of padestrians. Few references of horse traffic and Chariots are available, such as 'Yuan Chwang' came with his white horse from China and stayed at Nalanda for 5 yers. Road pattern was linear. Generally buildings were 4 storied, constructed with bricks and stones. Water supply for drinking water and sewage_

---

25. University Campus Planning:Cancepts and Standards M.C. Shah
School of Planning and Architecture, New Delhi, (1964).

disposal were also considered in campus designing.

Due to high discipline, strict punishments and close contacts between students and teachers, the overall environment on campus was very good for educational purpose. Campus was a community of scholars living and working, together which we are now trying to achieve in our new campuses.

' As the Kernal of the Cocoanut is in the whole cocoanut so the University is in the Society and in the numerous activities of our life'

R. Tagore

'The aim of University Education should be to turn out true servant of the people who will live and die for thi country'

Gandhiji

Harijan, August 25,1946
(The education quarterly,April'71

CHAPTER II

UNIVERSITIES IN PRESENT PERIOD

2.1 Pre-Independence Period: (British Period)

The British started Universities in India from 1857. The first proposal for founding a University in India was made by the Council of Education in Bengal in the year 1845 but it was not accepted by Board of Directors of the East India Company. The first three Universities started were[1]

a) University of Calcutta, Founded on 24th January, 1857.

b) University of Bombay, Founded on 18th July, 1857.

c) University of Madras, Founded on 15th Sept. 1857.

Technical colleges were opened at Poona, Gindi (Madras), Roorkee and Bengal Engineering College, Calcutta.

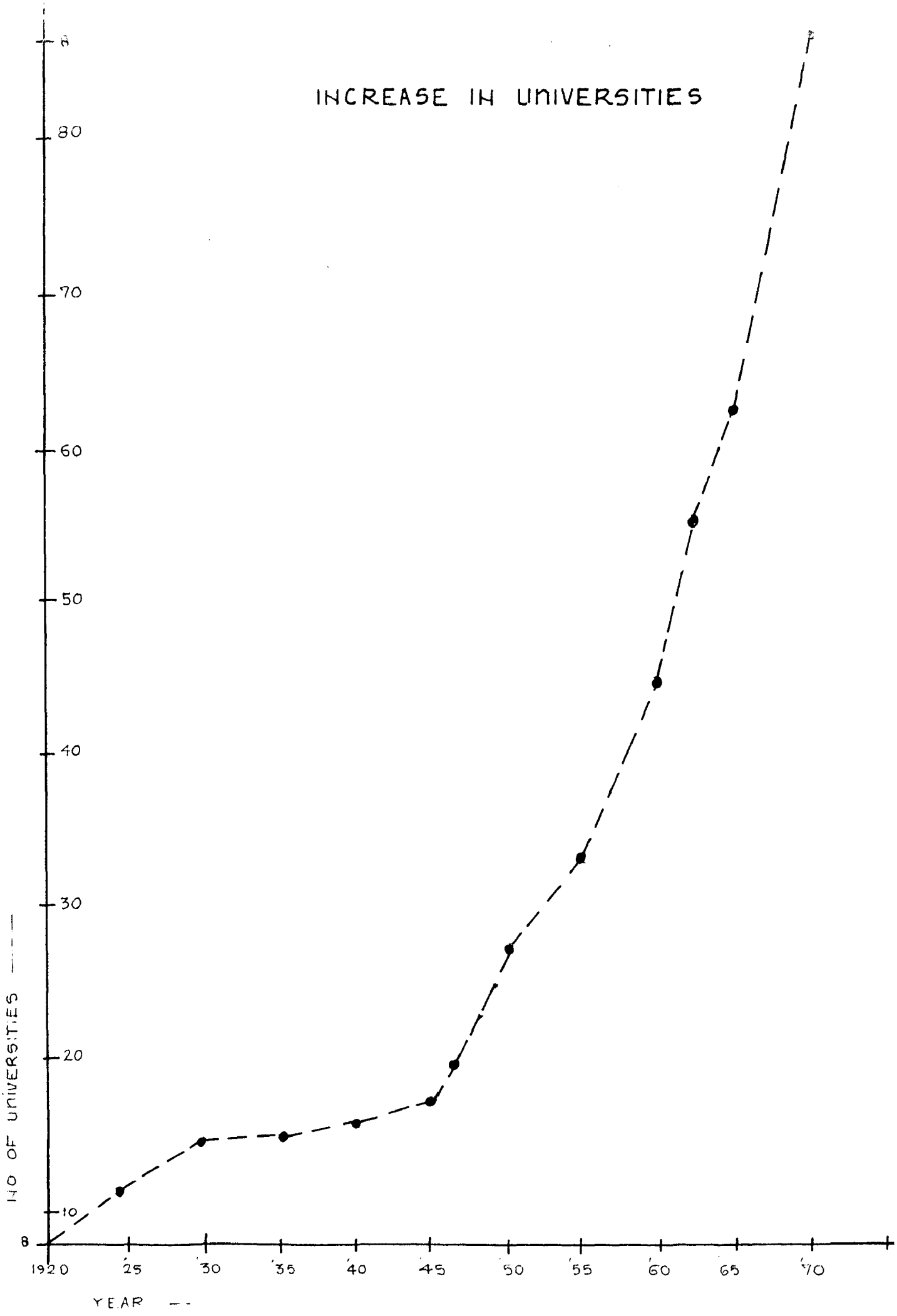
Main objective of Universities was to provide knowledge in English and Philosophy which would help them in ruling. Gandhi had said in his speech.[2]

'I say, without fear of my figure being challenged, successfully that today India is more illiterate than it was hundred years ago, because British administrators when they came to India, instead of taking hold of things as they were,

---

1. 'University Hand Book' India and Ceylone, page 24
   Inter University Board of India and Ceylone Publication.

2. 'Educational Planning and National Integration, page
   S. Ramnathan


INCREASE IN UNIVERSITIES
80
70
60
50
40
30
20
10
8
NO OF UNIVERSITIES
1920
25
30
35
40
45
50
55
60
65
70
YEAR

began to root them out'.

The out put of Universities was mainly that of clerks and not creative type of individuals.

2.3. Universities after Independence:

Before independence there were only 20 Universities in India. After independance the number of Universities increased rapidly and at present we have 86 Universities (including Agriculture Universities and institutes deemed as Universities). See the graph on plate No.6. This increase in number is due to:

a) Urge to have higher education

b) Necessity of the Country

c) To break existing over crowded Universities, into smaller Universities.

d) Political Pressure

e) Population increase.

In 1956 University Grants Commission was set up by an act of Parliament. This was an important step taken to develope facilities for higher learning and research.

Increase in students enrolment:

In 1947 the enrolment number was 4 lacs.[3] At the begining of 2nd five year plan, the number was 7,12,697.

---

3. Figures from information supplied by U.G.C. Office, New Delhi

During third plan there was an addition of 4 lacs of student in Universities, and today it is over 30 lacs (In 1970-71 figure was 30,01,292 students). Growth rate of higher education during last 4 years was about 13/ where as annual growth rate is only 4/.

2.3 Objectives of Universities:

University is a society founded for the advancement of learning, so it is constantly changing. As knowledge expands, number of departments and their sizes also increase. Its work is never completed, so every building on campus should be designed with this consideration. In his convocation address to the Univ city of Allahabad in 1947, Jawaharlal Nehru (First Prime Minister of India) defined University objectives thus[4]:

' A University stands for humanism, for tolerance, for reason, for progress, for the adventure of ideas and for the search of truth. It stands for the onward march of human race towards even higher objectives. If the Universities discharge their duty, then it is well for the nation and the people .'

The University is a place for exchange of ideas and shaping of out looks and creative research. The very objectives

---

4. 'Modern University', page 20.
A.K. Rice

PLATE No. 7

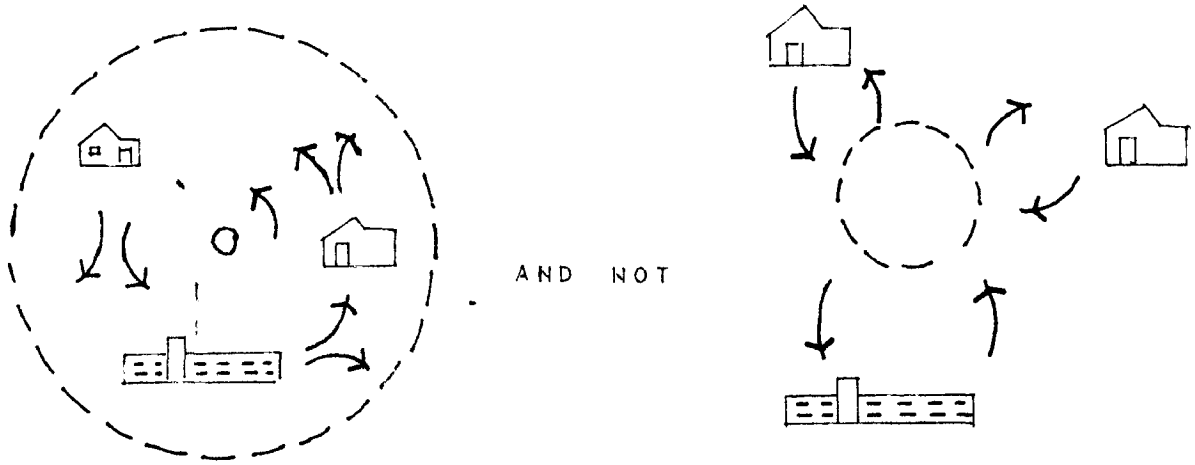


FIG A

THE UNIVE SITY A SOCIETY OF INDIVIDUALS LIVING AND WORKING TOGETHER FOR THE ADVANCEM T OF LEARNING

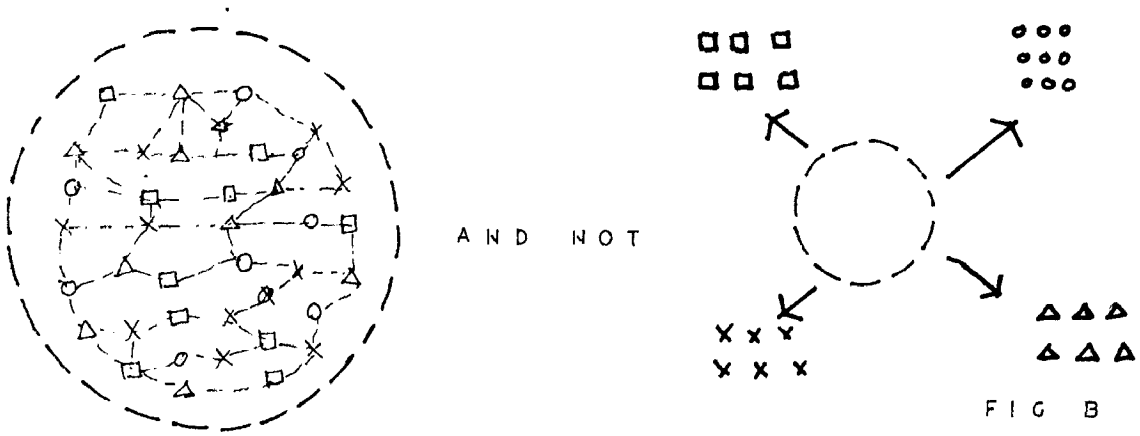
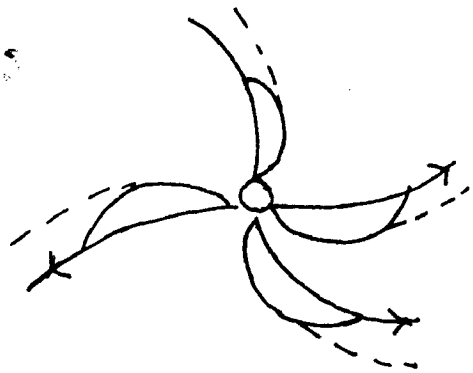


FIG B

A MEETING PLACE OF DIFFERENT APTITUDES SKILLS AND SPECIALIZATION

THE UNIVERSITY & CAMPUS

"Re[illegible]g in Br[illegible], page 42
R.P. Dober
Education Fro[illegible]y Laboratories, New York



AND NOT

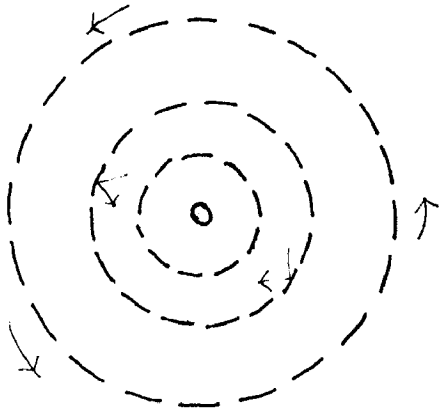


FIG - C

PROVISION FOR EASY GROWTH OF A CAMPUS

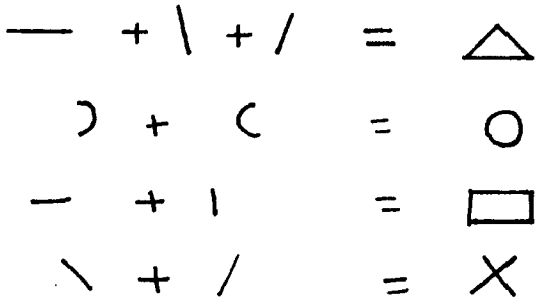


FIG - D

THE CAMPUS IS COMPOSED OF INDIVIDUALS AND GROUPS WORKING TOGETHER IN DIFFERENT DISCIPLES.

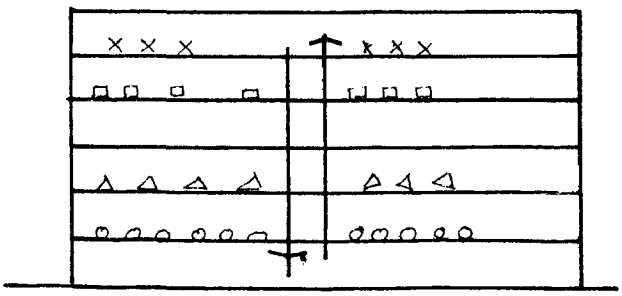


FIG - E

IN A PURPOSE BUILDINGS DISCIPLINE TENDS TO BE SEGREGATED BREAKING THE RELATIONSHIP FROM ONE FLOOR TO ANOTHER.

THE UNIVERSITY & CAMPUS

'C[illegible] Pl[illegible] [illegible] Ds[illegible]

F.F.L. Pu[illegible] [illegible]

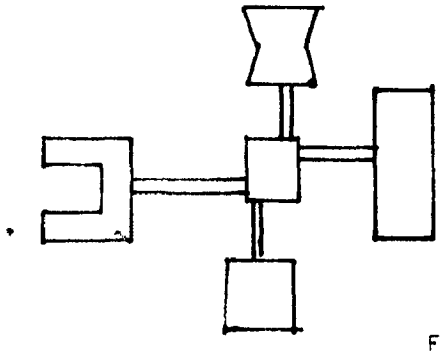


FIG-A

DISSOCIATION

THE EXTERNAL EXPRESSION OF DIFFERENCES IN FUNCTION AND FORM TENDS TO SEGREGATE THE UNIVERSITY INTO SPECIALIZED DISCIPLINE ONLY.

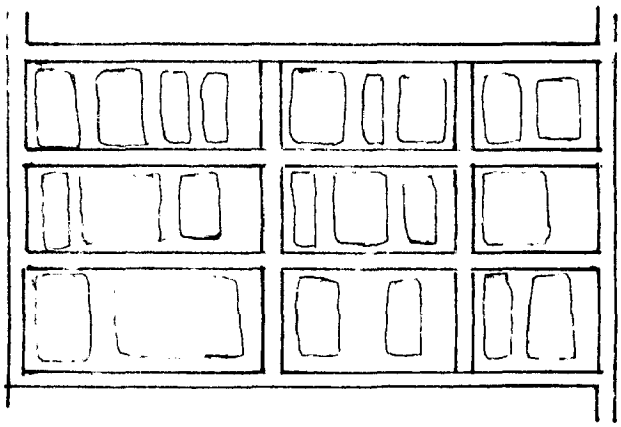


FIG-B

ASSOCIATION

SYSTEM-GIVES A MINIMUM ORGANISATION NECESSARY TO AN ASSOCIATION OF DISCIPLINES. THE SPECIFIC NATURE OF DIFFERENT FUNCTIONS ARE ACCOMODATED WITHIN A GENERAL FRAME WORK WHICH EXPRESSES UNIVERSITY.

FORMS & CAMPUS

of education have undergone a sequence of expansion as:

a) Education without buildings in natural environment.

b) Education within sheds or temporary shelters such as Ashramas.

c) Education within buildings.

d) Education within a proper environment.

The change in the educational patterns resulted in changes in campus planning and its three dimensions.

Architectural Interpretation of the meaning of University and campus:

See plates number 7 and 8.

2.4 Problems of our Universities and Necessity of Campuses for Universities:

How far our Universities are successful in achieving the above goals is important ? Information from Vice-Chancellors[6] shows that the problem of our Universities is very complicated. Until and unless University is improved completely it cannot satisfy there function. As a result of over crowding, non-availability of teaching staff unemployment there is a frustation among the students.

To satisfy the objectives and reduce over crowding, new campuses are essential with proper environment. The society must be able to maintain these campuses. In our

country economic level is low and that is why in many residential campuses students seek exemption from campus residence. This wastes their time and energy which could be better utilised for learning and research works. The problems are:

a) Inadequate finance

b) Political interferences

c) Organisational defects

d) Unemployment and frustration among students.

A University can not fulfil its objectives by continuing to remain as a static organisation. It should be a dynamic and progressive Institution and rapidly changing. Resources available are not adequate and larger out lay is needed for this purpose. Total expenditure on education is about 3 percent of Gross National Product. The 'KOTHARI' Commission noted.[7]

'The absolute amount per capita spent by us on education is about 1/100 of that spent by countries like U.S.A, Japan and U.S.S.R. These Countries are spending more than 6 percent of Gross National Product on education.

---

7. 'Problems of our Universities', page 24
K.K. Datta
The Education Quarterly, October 1971.

Expenditure under plans on University Education:

Ist Five Year Plan	...	14 crores
2nd Five Year Plan	...	48 crores
3rd Five Year Plan	...	87 crores
4th Five Year Plan (1969-71 Figs.)	...	183.52 crores

This amount is distributed as:

Central	State	Union Territory	Total
103.99	76.06	3.47	183.52 crores

Due to shortage of money, University can not initially develope campus as per requirements, but have to plan in different phases. The land is the main problem for any new establishment of University. In urban areas, such large areas of land are either not available or land cost is too high, thus creating a problem for a residential campus.

2.5 Location of Campus in Relation to City:

From location point of view campuses can be divided as follows:

a) Urban Campuses

b) Sub-urban Campuses

c) Rural or Country side Campuses.

a) Urban Campuses:

(i) Technical campuses in urban areas provide better research facilities for students and industries. Students can use city facilities such as markets, picture halls, shopping centres etc. Citizens can also utilise University facilities. This results in a compact campus. Transportation cost is lesst-but it adds more burden on existing city services. Campus may be on the outskirt of a city or may be as a wedge in the heart of city leading to out side[8] (see plate no.9, Fig.A).

(ii) Campus as a wedge in the heart of a city:

This is ideal for the design of a new city and University. It has some advantages over other types as follows:

Campus is designed in three zones-first zone of residences near the city centre (see plate 9 Fig.C), and development is multistoried and compact. So residences get the advantages of city centre and there is no necessity of providing separate facilities.

The second zone viz the educational zone have loose grouping and slightly horizontal spread out planning. So the academic buildings are separated from city disturbances like noise and traffic hazards. Also it has easy access to the city.

The third zone is of field activities and so is

---

8. 'The University in the City' page
Architectural Review, July, 1964.

placed away from the city centre.

The main problem is of traffic separation particularly in first zone. The other draw back is that of little chance for future growth.

b) Sub-urban Campus:

The campus is outside the city boundry, generally 5 to 7 miles away from city-so it should be a self sufficient campus. It cannot have the advantages of city facilities and services. Thus development cost for this type is much higher than urban campus. Main advantage is that sufficient land is available for campus and no disturbance of city traffic. These campuses are generally planned with horizontal spread out buildings and economic use of land is not considered which is main disadvantage of this type (See plate 9, Fig.b).

c) Rural Campus:

Campus is located in rural areas. This has main advantage of availability of land. This is suitable for Agricultural Universities where a vast expanse is needed for farms and experimental fields. So these Universities are better located in rural areas. Disadvantages are: the cost of development and constructional costs are more. Transportation cost also increases.

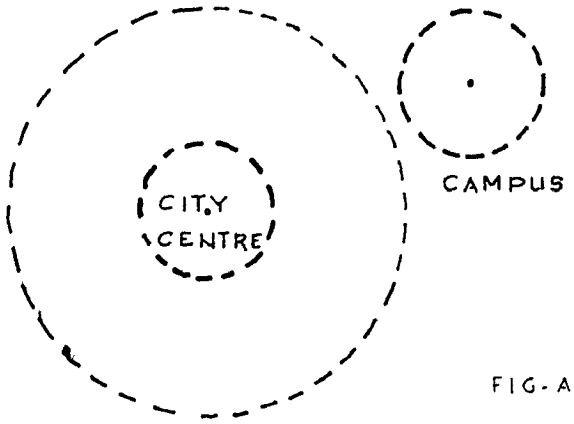


FIG-A

URBAN CAMPUS

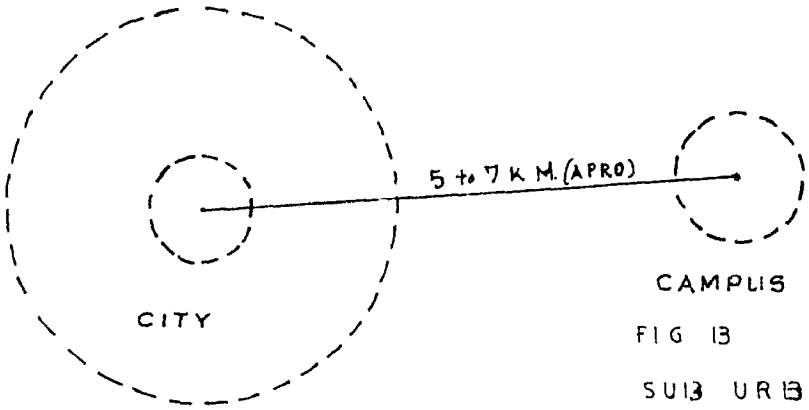
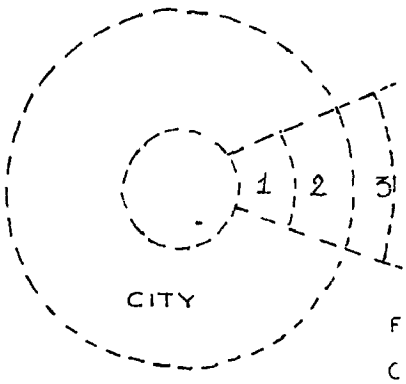


FIG 1B

SUB URBAN CAMPUS



CAMPUS

1. Residential Zone
2. Academic Zone
3. Field Activities

FIG C

CAMPUS IN THE HEART OF CITY

CITY & CAMPS LOCATION

Fig.C 'Architectural Review', page No. 9

July [illegible]

Campus may be classified as:

1) Homogeneous type

2) Heterogeneous type

1. Homogeneous type:

There is homogenity or uniformity in the land use, in designing and grouping of different buildings. They have some common denominators such as scale, proportion, materials, surface finishing and texture and fenestration.

2. Heterogeneous type:

A type of campus in which there is no uniformity in land use (mixed land use), in designing and grouping of buildings. Each building has its own individuality. There may or may not be some common- denominators as in homogeneous type.

2.6 Campus Planning Concepts:

Different factors affecting campus forms are:

a) Nature of site

b) Climate

c) Materials and technology

d) Functional requirements

e) Educational aims and objectives

f) Finance available

g) Designers philosophy and client's aspirations.

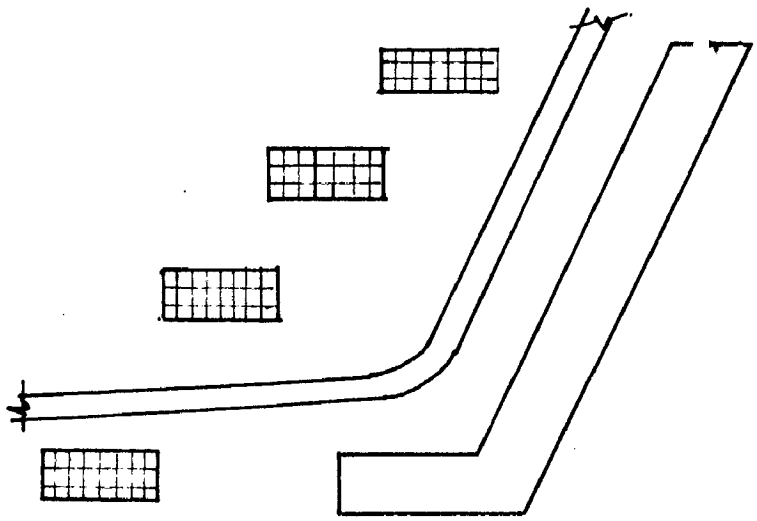


FIG A

LEARNING LIVING LEISURE S

LINEAR CONCEPT

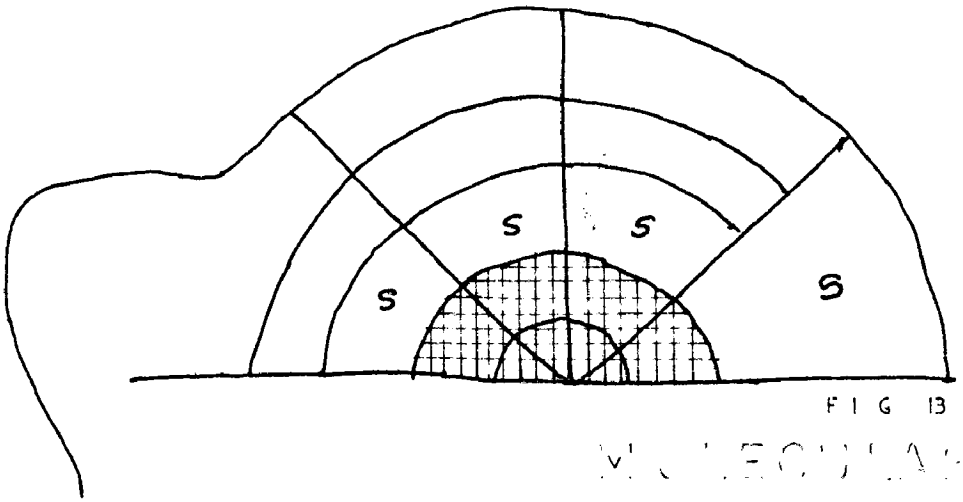


FIG B

CAMPUS PLANNING CONCEPTS

Given below are some different planning concepts.

a) Linear Concept

b) Molecular or concentric zone concept

c) Multiple unit concept.

d) Doctor concept

a) Linear Concept:

In this type residential and academic areas run parallel to road in a linear direction. Leisure areas are distributed at some points. Continuity of structures is easily achieved here. It is quite a compact campus. But due to linear development, walking distance is increased. Moreover campus becomes monotonous and loses its charm. (See plate 10 Fig.a).

b) Molecular or Concentric Zone:

Here the three main activities of campus form three zones and these zones are concentric. At a time we can develope one zone. Inner zone or nucleus is generally sports area or academic, second zone learning or sports and third zone for residential needs. This type of development requires more land, also circulation space required is more than other types. So overall cost of development increases. Proper orientation for buildings cannot be achieved (See plate No.10, Fig.b).

PLATE No. 11

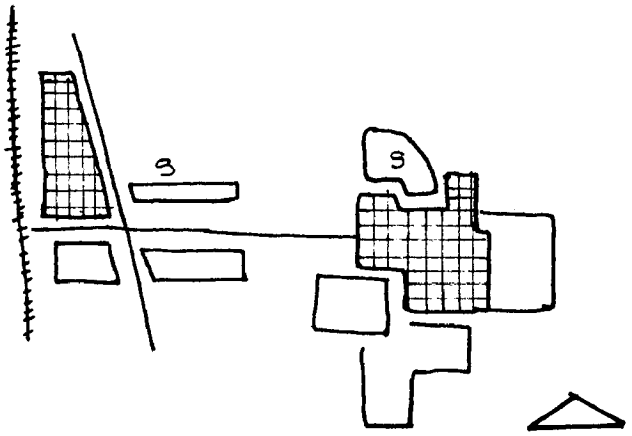


FIG - C

MULTIPLE-UNIT

AUNA WALI UNIVERSITY

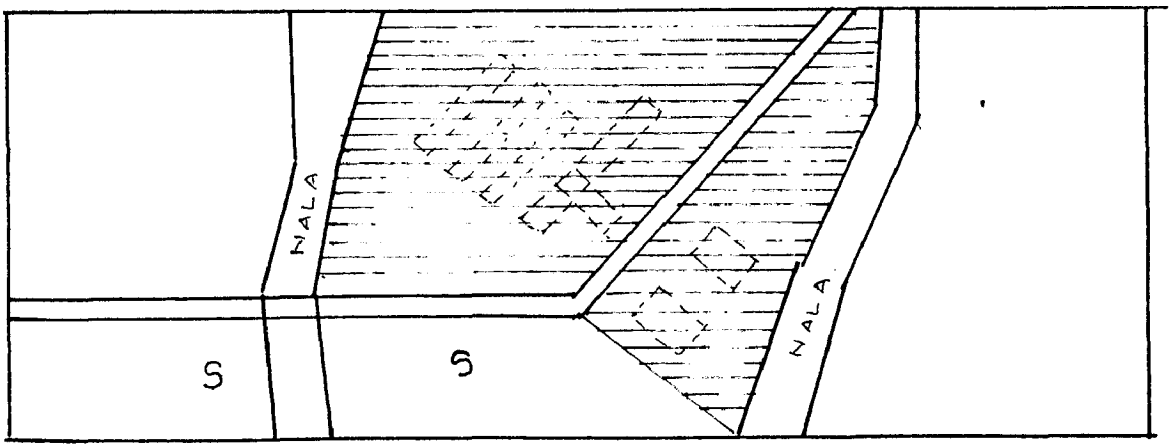


FIG - D

I.I.T. DELHI

SECTOR CONCEPT

CAMPUS PLANNING CONCEPTS

Fig.C. 'Concepts of Campus Planning and their land use Pattern in India' Kulshrestha

I.I.A. Convention, Roorkee, 1970

c) Multiple Unit Concept:

The campus has number of self sufficient units each comprising learning, living and leisure activities. These units are repeated. Future expansion is easy, moreover campus can be designed in a compact style. (See plate No.11 Fig.c).

d) Sector Concept:

Here the learning living and leisure areas form different sectors. Generally academic sector is in between the other two. Some of the disadvantages are:

(i) Road pattern is gridiron and not interesting.

(ii) In each sector a provision for future expansion is essential so more open spaces have to be left out in the campus.

This results in a spread out campus.(See plate No.11 Fig.d).

2.7. New Universities and Campuses:

The changes in academic pattern are reflected in physical planning. In new Universities, the system of different departments and their separate buildings is replaced by 'Schools of Studies'. (In I.I.T., Kanpur this system is adopted). This breaking up of departments has a considerable influence on planning, there is no need to duplicate facilities. It gives a new relationship and a new direction to campus planning.

In new Universities more emphasis is given on audiovisual aids in teaching. So we will have to consider the installation of close circuit T.V., computers and communication systems.

Concluding Remarks:

Every year enrolment number in Universities is increasing rapidly. The increase is about 13 percent per year and we have to provide a seat for them. Existing Universities are over crowded and not able to expand further to accomodate this increased number. So new Universities are coming up. A panel of Asian Institute of Educational Planning has also suggested opening of more Universities to cope with increasing enrolment.[9] We must carefully design these new campuses which will be in accordance with new teaching systems. Also problems of our existing campuses viz. over crowding, inflexibility, no provision for future expansion should be considered and avoided as far as possible. Planning concept of campus should be such that it will take care of all above mentioned points and also give a most economically planned campus.

---

9. 'Panel report' Asian Institute of Educational Planning Prof. M.V. Mathur, Director

Times of India, Delhi 27th Aug. 1972.

Part 2: Study of External Services

CHAPTER III

TRAFFIC IN CAMPUSES

External services in a campus includes:

a) Circulation systems - Roads, Pedestrain Paths etc.

b) Sewer Lines

c) Storm water drainage

d) Water supply

e) Electricity and telephone lines

f) Gas supply

Out of all these services the most important from architects point of view is circulation system and this is dealt in detail in this chapter. Other services are considered in the next chapter.

3.1 Circulation Systems:

The campus circulation system or campus traffic is of three types.

a) Vehicular (power driven)

b) Pedestrian

c) Bicycle

The problem of traffic will vary in magnitude according to the campus type, its location in relation to a city and the influence of the society. In fully residential campus, vehicular traffic is less than pedestrian traffic as compared with non residential campuses. Traffic distribution depends on arrangements of land use selection of site for buildings.

3.2 Roads and their Classifications:

The Romans were the pioneers in scientific road making. Roads were essential for military action. The first road 'Appean Way'[1] was laid in 312 B.C. and was 360 miles long.

In India record of road is mentioned in Rigveda and the high ways were called Maha-Patha. Road width varied with type and use. Traffic consisted of carts, chariots, elephants etc. Provision of footpaths (Padya or Paksha) on important roads was a common feature and its width was 1/3 rd of a carriage way. Separate carriage ways were provided for each type of traffic on arterial high ways. The roads had Parshwa-Khatan or side gutters. Nalanda, Taksha-Sila also had planned road patterns. The roads were straight and narrow.

Function of the roads:

From the earliest periods roads had two main

---

1. 'Road Engineering' page 3
   Professor Sahani
   Sugrantha Technical Publication, Railway Road, Roorkee.

functions:

a) A means of direct access to buildings

b) A means of physical communication from place to place for people and vehicles.

The use of power driven vehicles has changed road planning considerably.

Classification of Roads:

A street can be defined as,[2] 'A form of layout consisting of carriage way for vehicles flanked by pavements for pedestrians and frontage development with direct access to premises for pedestrians and occasionally for vehicles.

Difference between Roads and Streets:

The former relates to routes which are primarily used for carrying traffic and the latter to those which are developed with adjoining buildings and are primarily used for giving access to buildings.

Wade, Telford and Mc-Adam are the three men who introduced scientific methods of road making.

Roads are classified here as under:

A Classification of Roads by traffic Motion:

a) Arterial Road:

Roads serving the country as a whole, or a region

2'The Street in Evolution' Page 6
N.P. Allen
Journal of Town Planning Institute - Feb. 1967.

of the country and linking up the main centres of population or the various regions.

b) Through Roads:

These are roads carrying traffic, which has originated in one area of the town and having its distination in another area.

c) Local roads:

This includes all other roads in the town except development roads.

d) Development Roads:

These are roads whose primary function is to provide frontage for the development of the land.

e) Side walks or pavements:

That part of highway exclusively reserved for the use of foot passengers, generally running parallel to the carriage way and separated therefrom.

B. Classification by Materials of its Super Structure:

From material point of view, roads can be classified as follows:

a) Earth roads

b) Gravel roads and murrum roads

c) Water bound Mc-Adam roads

d) Bituminous roads

e) cement concrete roads

f) Paved roads of bricks, wooden blocks, stone, metal sheet, concrete blocks etc.

C. Classification from Constructional point of View:

a) Flexible structures

b) Rigid structures

a) Flexible Structures:

A form of road construction which for the purpose of design is assumed to have no tensile strength. These roads are built up of layers of granular materials. In upper layer the binding agent is usually bitumen or tar viz McAdam roads.

b) Rigid Structures:

A form of road construction in which tensile strength is considered for the purpose of design viz concrete roads.

Roads in a Campus:

Roads in a campus can be classified as follows:

a) Major Roads:

Which carry traffic to and from the campus gate way, connecting points of origin and destination

within a campus.

b) Minor Roads:

This includes bicyle tracks.

There is a hierarchical relationship between various segments of circulation system on and off the campus based on scale of motion. The sequence should be as follows:

Major Community Road

Campus gate way

Major Campus Road

Minor Campus Road

Destination Point

3.3 Vehicular Movement (Road Pattern) in a Campuses:

The road pattern should be in accordance with site contours and should satisfy the requirements of traffic flow. There should be a sense of arrival and departure, of moving from one place to another. It is this pattern which will make the anatomy of the whole development comprehensible to any body moving on campus. Road pattern should enable areas at the centre of University to

be kept free from traffic. Four principal types of road pattern used in campuses are as follows:

a) Gridiron

b) Linear

c) Radial

d) Curvilinear

a) Grid-iron pattern:

It is most commonly used in campus developments. Some of the drawbacks in this type are:

(i) it makes walking or driving unpleasant due to visual monotony.

(ii) The straight line indicates an urgent goal.

(iii) This is suitable only for plain land and where vehicular traffics is more than other form of traffic.

(See plate 12, Fig.A)

b. Linear Pattern:

The linear system of circulation connects flow between two points. If movement along its length is over loaded, traffic may become impeded. Loops are added to aid local flow (See plate 12, Fig.B).

c. Radial Pattern:

Radial system directs flow to a common centre or away from common centre where high level of activity exist.

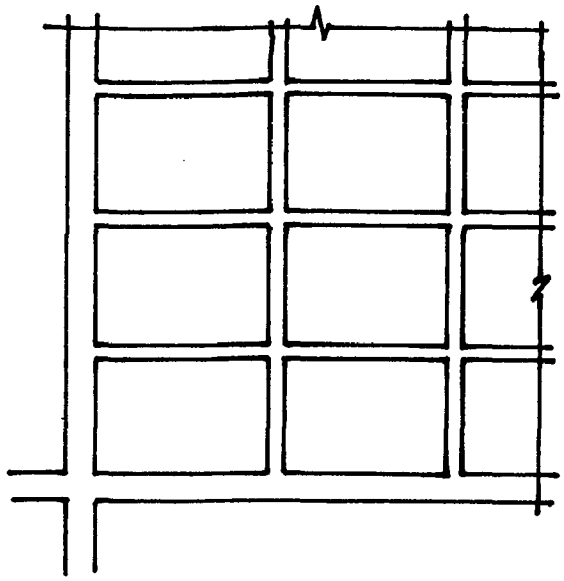


FIG-A

GRID IRON PATTERN

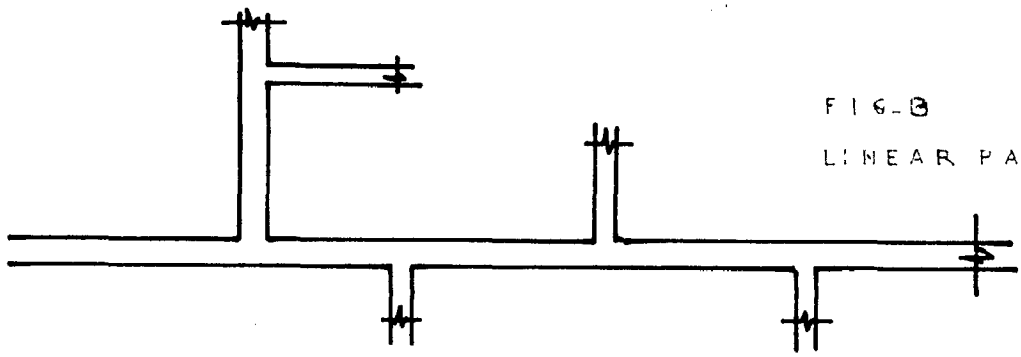


FIG-B

LINEAR PATTERN

FIG-C RADIAL

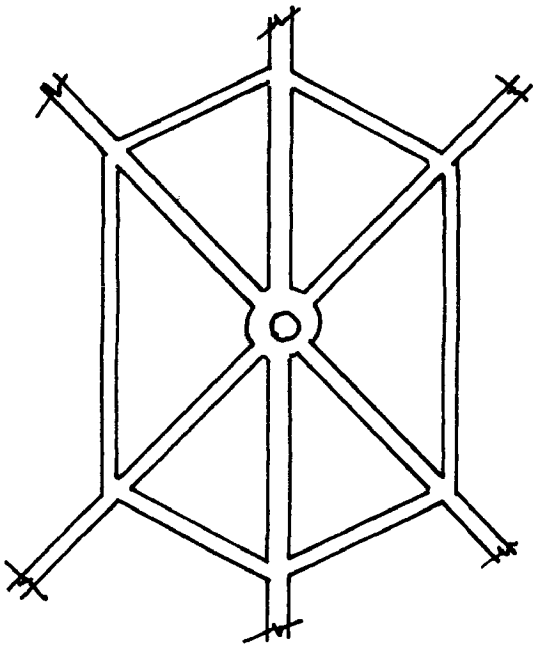
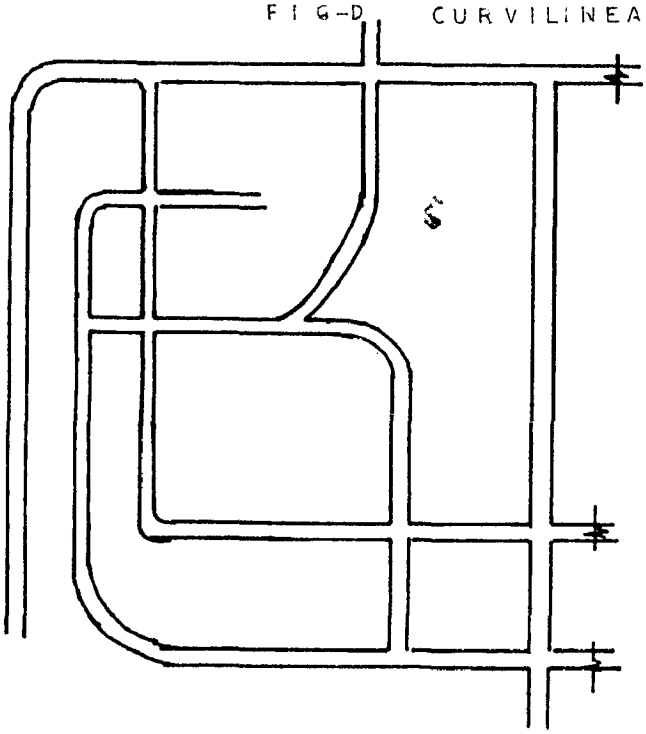


FIG-D CURVILINEAR



ROAD PATTERNS

Though it makes travelling pleasent due to changing view of buildings, it increases road lengths. Also orientation of buildings changes. This system is not flexible as the grid iron. Rings may be added for future expansion. (See plate 12, Fig.C).

d) Curvilinear Pattern:

This system gets the advantage of topography by following the land as close as possible. This system is closely related to traffic at the local level. There are few straight roads, cul-de-sacs, dead end streets are also used. All these elements have a tendency to slow down the traffic. Streets are more intresting because of varied view, street types and topographical changes. This is suitable for a campus where land is not plane (See plate 12, Fig.D).

Movement of Vehicles:

The space, time, scale in a fast moving vehicle makes appreciation of details impossible and the rhythm of any route, the punctuation and elements placed along it must be in size and in scale with the speed. The designing of roads should co-relate its purpose and characteristics. Road capacity varies with speed and is

maximum at 40 miles per hour. (See Appendix I).

3.4 Vehicle Parking:

Use of automobiles is increasing day by day. Automobiles have changed from a luxury to a convenience and in many places from convenience to a necessity. Parking for this is very essential. Parking is a large consumer of land. For determining parking programmes following points should be considered.

a) Identify nature of parking requirements.
b) Estimate number of spaces required to serve specific activities.
c) Determine where these are to be located.
d) Cost of construction for covered parking facilities.

Parking requirement can be classified in three categories.

a) Obligatory
b) General
c) On token rent

Parking for staff, visitors for students who have no other means to reach the campus constitute the obligatory category. In our campuses, though at present vehicular traffic is not so much as in foreign campuses yet we have to take in to consideration parking problem as use of

automobiles is increasing very rapidly.

3.5 Road Furniture:

Road Furniture includes

a) Traffic signs and signals
b) Road lighting
c) Guard rails and other physical barriers
d) Public conveniences viz drinking fountains, litter bins etc.
e) Trees and shrubs
f) Telephone and electric poles
g) Street name plates
h) Statues and memorials

Detail designing of these furnitures will vary from campus to campus and should be carefully considered so as to make better road scene.

Street Lighting:

Its purpose is to provide illumination at night for the traffic. Research has shown that visibility of objects on roads is about the same although there is wide difference in colour between sodium vapours and mercury vapour and fillament lamps. Light distribution will depend on width, surface brightness and luminarie spacing.

This spacing is given by the formula given below:[3]

$$\text{Spacing} = \frac{\text{lamps lumens X Coefficient of Utilization X Maintenance factor}}{\text{Average foot candles X Street width}}$$

3.6 Storm Water Drainage:

One of the essential functions of a road surfacing is to make it reasonably water proof so as to prevent water reaching subsoil and thus to prevent uneven settlements. It is also essential to shape the surface so as to drain out the water into side channels or storm water drainage.

Three cross sections of roads with different camber are given below

a) Parabolic camber

b) Barrel camber (mid third parabolic)

c) Uniform cross fall.

Fig.A Fig.B Fig.C

3. 'Fundamentals of Traffic Engineering' page
H. Kennedy and W. Homburg

Slope for Surface Drainage:

Slope required for different surface materials is as follows[4]

No.	Road surface	Cross fall	Long fall
1	Concrete	1 in 60	1 in 100 to 1 in 150
2	Tar	1 in 48	1 in 200
3	Gravel	1 in 30	-
4	Paved Slabs	1 in 72	-

3.7 Traffic Segregation in a Campus:

Traffic segregation is essential in a campus and particularly in academic zone if vehicular and pedestrain traffic is more. To have a safe pedestrian movement these two must be separated otherwise it will create nuisance to each other. Traffic segregation can be achieved by following ways.

a) Horizontal traffic segregation.

b) Vertical traffic segregation with pedestrians above.

c) Vertical traffic segregation with vehicle above the ground.

4. 'Design and detail of the spaces between the Buildings, page 98 Elizabeth Beazly
Architectural Press Ltd. London 1969.

d) Vertical traffic segregation with vehicles at ground level and pedestrians under ground.

In our campuses vehicular traffic is not predominant, moreover land is available for horizontal segregation. This is easy and economical than other methods, and so is practiced now a days in new campuses. Where ever vertical traffic segregation is essential it is better to have vehicles at ground level and pedestrians under ground rather than other two solutions.

3.8 Pedestrian Movements in a Campus:

Pedestrian circulation system needed on most of the campuses should be as follows:

(a) There should be a transition area between buildings and pedestrian path. This may be a plaza or enlargement of path in front of buildings. This allows ample movement during the crucial ten minutes between periods.

(b) Major Pedestrian Paths:

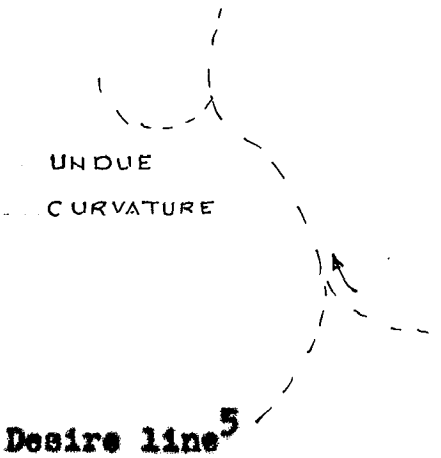
These are the most direct lines between origin and destination for the heaviest pedestrian traffic.

(c) Minor paths:

These are other designed walks and areas giving

pedestrian access to building and out door spaces.

Path system should satisfy 'desire-line' of pedestrians. The tendency to curvilinear movement is universal



Desire line[5]

The degree of curvature is modified by various factors such as speed and urgency to reach specific goal. Pleasure in movement can be achived by curvature and varying widths of paths.

Functions of Paved Surfaces are:

a) To provide a hard, dry and non slippery surface which will carry the load of traffic.

b) To provide sense of direction.

c) To provide a sense of repose.

d) To provide an indication of hazard by change of materials.

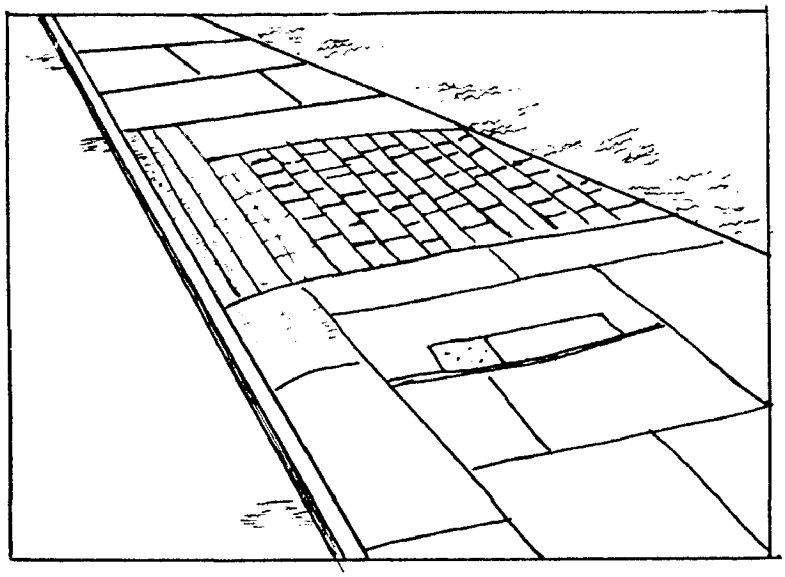
e) To reinforce character of particular place.

See plate No. 13 and 14, Fig. A.B.C.D.

---

5. 'Planning for Man and Motor' page
Paul Ritter
Pergammon Press Oxford, London, New York, Paris.

PLATE No. '-



Texture Suggest
Hazard while walking

Sug est direc-
tion for
pedestrians

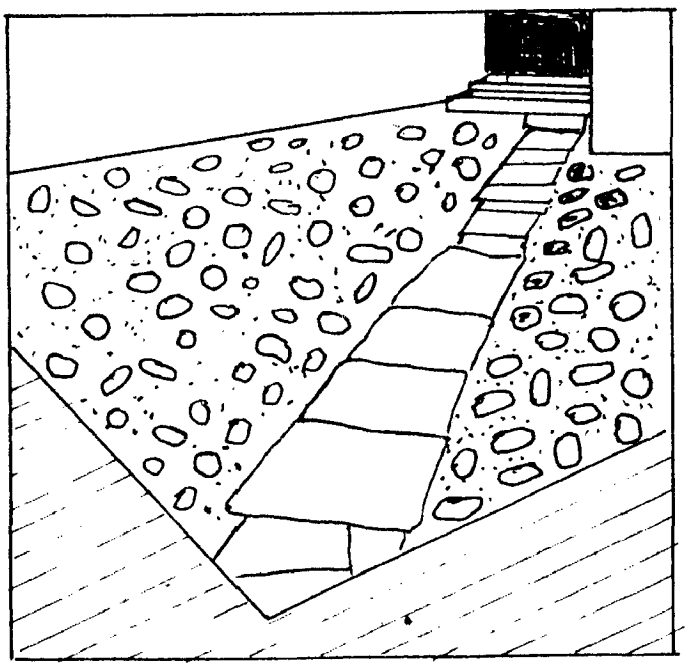
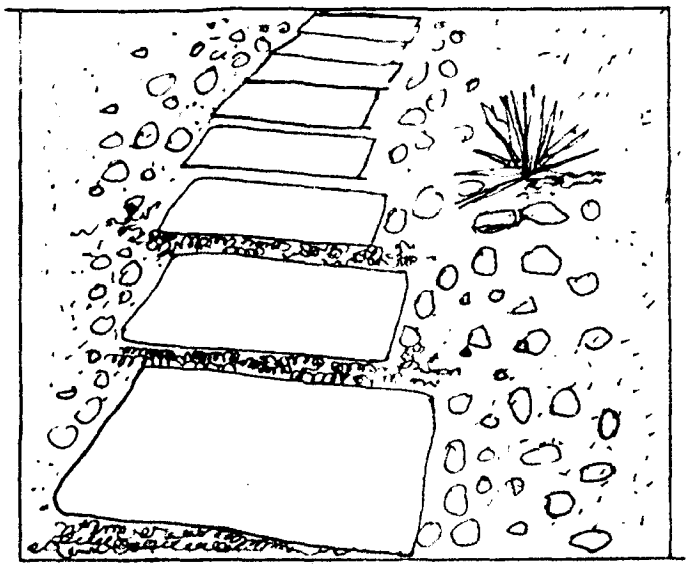
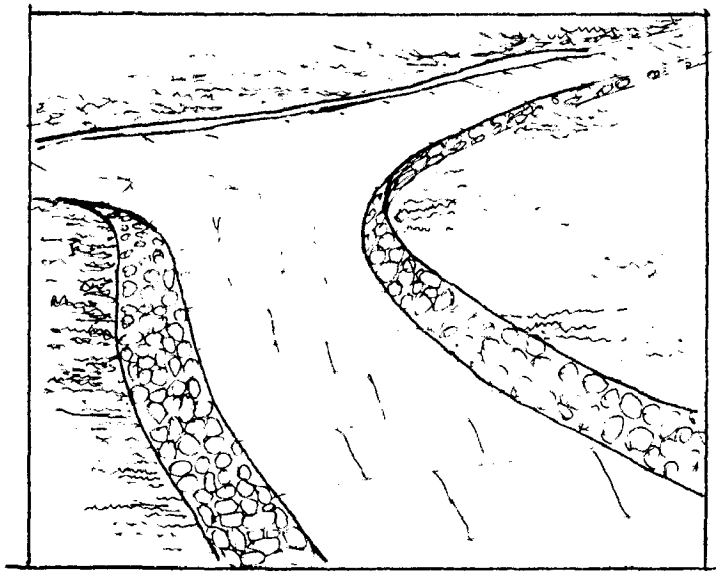


PLATE No. 14



Paving slabs laid in gravel, gives direction and stops walking on side grass. Grass in between slabs gives relief while walking.



Pedestrian path follows the topography. Side cobbles reduces the scale of paths also stops walking on grass

'Design and detail of the spaces between the buildings' page 1.o.
Eliza-beth Beazly
Architectural Press Ltd., London, 1969.

According to American authors,[6] pedestrian traffic at the rate of 18 to 27 pedestrians per 22 inches lane per minute, is considered a reasonable maximum.

Path systems are among the principal elements which give shape to the open space of the campus and the visual direction. The pedestrian movements require interest and variety in spaces, producing an impression of rapid change under slow foot movements. Frequent punctuations by focal points on paths are required.

Differentiation between areas can be created by creating different environments on paths. Pleasant walk is a shorter walk than a tedious one.

3.9 Bicycle Traffic in a Campus:

In our campuses vehicular traffic is not as predominent as bicycles, particularly in partly residential and non residential University campuses. The bicycle does not fit into either the vehicular or pedestrian category. In volume bicycle can be as hazardous to pedestrians as automobiles are to bicyclists. Bicycle riders expect to be able to put their bicycles at the front of building.

Bicycle track when not designed separately should

---

6. 'Planning for Man and Motor' Page 15
Paul Ritter
Pergamon Press, Oxford, London, New York, Paris.

be a special lane in minor roads and major pedestrian paths. Cycle track should be physically separated from them by hedge or some sort of railing. The track width should be 9' and for more traffic 12' or 15'

Concluding Remarks:

From the above points it is clear that while planning any campus full consideration should be given to the three types of traffic viz. vehicular, bicycles and pedestrian. Furthermore, these should be segregated from each other as far as possible.

The road pattern should follow the topography. It should not delay the traffic and should take vehicles as near to the point of destination as possible so that walking is restricted to a minimum and pedestrian movements inside the zone are not disturbed. It should avoid unnecessary increase in lengths. Pedestrian paths should be along shorter routes. Considerations should be given to pattern, surface materials, treatments etc.

Thus this will make driving, walking and bicycle riding a pleasent experience. Also this will satisfy the traffic needs of a campus.

CHAPTER IV

OTHER EXTERNAL SERVICES IN A CAMPUS

Other services include Sewerage, Water Supply, Electrical Lines and Telephone Lines. Some of these services are kept underground while others are not always underground. Services above the ground affect the total picture of the campus and hence should be considered from the aesthetic point of view and also from planning point of view.

4.1 Sewerage:

Definations[1]

(a) Sewage:

Sewage is defined as 'The liquid waste of the Community which may consist of foul water, trade effluent and surface water.

(b) Sewerage:

A system of pipe lines, conduits and ancillary works constructed to convey sewage from its points of origin to the place of disposal.

The ancient world had achieved a remarkably high standard in sanitation which unfortunately was lost and was

---

1. 'Civil Engineering Code of Practice', page 5 and 6 Vol. No.5 Drainage and Sewerage.

not achieved until 19th century. In the palace of 'Knossos' in Crete the latrine was built over a channel with constantly running water.[2] Water closets were introduced for the first time in England about 1810 and sewers were laid to take their discharge.

Different Systems of Sewerage:

Different systems of sewerage are:

a) Separate system:

In this system only foul sewage is discharged and all surface water is discharged to a separate surface water drainage. The foul sewer will be of smaller diameter but comparatively steep gradient is required. The surface water sewer will be large in diameter and at smaller depth.

b) Partly Separate Systems:

Under partly separate system some surface water usually back roof and drainage from paved brick yards is admitted to the foul sewer and the balance is discharged to a separate surface water sewer.

c) Combined System:

A single sewer carries the whole of the foul sewage

---

2. 'An Historical out line of Architectural Science' page H.J. Cowan Elsevier Publishing Co., New York, 1966.

plus all surface waterand so diameter is large but gradient and depth are less.

No storm water overflows are required under the separate system and no pollution of water source from the foul sewer can thus occur. But the combined system has this disadvantage. Separate system is more costly than the combined system in initial capital out lay. Partly separate system is suitable to our urban campuses.

Layout of Sewers

A sewerage should be designed to make the best possible use of natural slope of the ground. The maximum depth should not be excessive. Sewers under the road or foot paths should be atleast at a depth of 4 foot. For self cleansing, velocity of liquid waste should be 2½' per sec. i.e. 150' per minute. Circular sewers give the greatest resistance to both internal and external pressures.

While designing a layout for a Campus an important point to be considered is the interrelationship of buildings, site and surrounding Municipal services. The latter two strongly influence sewer design. Proximity of Municipal sewer is a great advantage to the urban campus, otherwise a provision of sewage disposal has to be made. Another point to be considered is whether existing services

can meet the demand for a fully developed campus plus growth of sorrounding localities. Once the primary services are available at the site the next stage is designing of intra campus services. For this topography and sub-surface conditions should be studied.

Sewage flow during the early years of campus growth may be so low that self cleansing velocity 150' per minute may not be achieved in the designed pipe line. In this case if air circulation is not sufficient then sulpher compound in sewage give two problems.[3]

1) Formation of Hydrogen Sulphide (H_2S) and so air pollution.
2) Formation of Sulphuric acid (H_2SO_4) which destroyes concrete.

This can be avoided by

1) Aeriation of septic sewage
2) Chlorination before sewage is discharged to concrete sewer.
3) Use of Ammonia.

If this possibility exists it is better to protect

---

3. 'Campus Planning' Storm water and sanitary drainage, page 40. A.L. Calenda
Building System Design, July, 1971.

concrete surface by plastic lining. Joints in pipes should also be resistant to the action.

Materials and method of Construction of Sewer:

Materials used for sewer lines are:

a) Glazed stone ware pipes:

These are generally available in 2' diameter and more diameter pipes are not easily available as breakage is more while handling and transportation. They are not used now a days.

b) Brick sewers:

It is not convenient and economical to built brick sewers.

c) Cast Iron and Concrete Sewers:

In areas where underground sewer is not available either we have to make provision of sewer lines and sewage disposal plant or have to use septic tanks.

Diamter of Pipes:

Diameter of pipe will depend upon the number of toilets connected to it, which will further depend on number of users. In academic zone water required for sewage disposal is 10 gallons per person per day. Diameter of pipe requred can be calculated by the formula

$\frac{Q}{V} = A$ where Q = 10 x number of users

$d = A/2$ V = velocity 2.5' per sec.

A = Area

(To avoid excess internal pressure and for emergency sewage flow is only upto $\frac{1}{2}$ the diameter so d = A/2).

4.2 Water Supply Lines:

One of the fundamental differences between civilization and barbarism is related to the installation of piping systems for providing adequate, pressurized supply of safe drinking water and disposal of sewage and storm water.

Ruins of plumbing systems of IndusValley date back to 3000 to 6000 B.C. Our earliest archaeological records of central water supply and waste water disposal date back to about 5000 B.C. to Nippur of 'Sumeria'. In the ruins, an arched drain is found having stone 'Vousseirs'. water was drawn from wells and cisterns. In the early 19th century European cities started to provide these services beneath city streets.[4]

Distribution Systems:

Distribution Systems for water supply are:

a) Dead end.

---

4. 'Standard Plumbing Engineering design, page 1 Louis-S-Nielson MacGraw Hill Book Company.

b) Grid Iron

c) Ring system

d) Radial system

Water requirement in academic zone is 30 gallons per person per day (approximately) and pipe diameter can be calculated from the following formula.

$\frac{Q}{V} = A$ where Q = 30 x number of users x 1.5 (1.5 for seasonal variations).

V = 4' per second. Economical value of velocity.

A = Diameter required.

Materials:

Materials used for water supply lines are

a) Lead pipes

b) G.I. Pipes

c) A.C. pipes

These conventional materials have some draw backs such as:

(i) Transportation cost is more.

(ii) More damage during transportation.

(iii) Over all cost is not economical.

Plastic pipes have some more advantages over these

traditional materials. It is light in weight and so easy for transportation, there is no corrosion problem. Installation is easy and economical, and the jointing is equally secure. Three types of plastic pipes are

(i) P.V.C. Poly-vinyl-chloride.
(ii) Low density polythylene
(iii) High density polythylene

These thermo plastic pipes have a limited temperature range in operating conditions, both for pressure as well as non pressure application. Hence these pipes are suitable only for cold water supply. P.V.C. pipes are available in 15 mm to 600 mm diameter. Production of P.V.C. pipes in India during 1970 was 1500 tonnes.

P.V.C. piping system is 40 to 60 percent more economical for cold water services when compared to G.I. pipes in 50 mm and 65 mm diameter size, 10 to 15 percent more economical in 50 to 150 mm. diameter size as compared to A.C. pipes and 15 to 20 percent more economical as compared to G.I. Pipes in 50 to 165 mm. size[5].

For properties of plastic pipes, See Appendix II.

'Plastics in building Industry', page 27.

Journal of National Building Organisation, April, 1971.

4.3 Electricity Lines:

The use of electricity in buildings is a recent development. The generator was invented by Faraday in 1831. The electric bulb was first demonstrated by Thomas A. Edison on 31st December 1879, which culminated later into use of electricity for lighting in 1881. 'Savoy' theatre in London was the first building to be illuminated in 1881.[6]

Service Lines:

The service line is that which brings the electrical energy from the suppliers lines to the consumers buildings. These service lines can be laid

a) Over head

b) Under ground

When a number of buildings are grouped together, as in campuses or other complexes then for providing a service connection to all such buildings, it is convenient to have underground service mains. Furthermore this does not spoil the beauty of buildings by having over head service connection also there is saving in land.

Before planning the layout for electrical system,

---

6. 'An historical outline of Architectural Science' page 109 Henry J. Cowan Elsevier Publishing Company, New York, 1966.

decisions must be made regarding the type of electrical services, type of interacampus distribution system, and voltage required etc. Electrical load for a campus increases in the course of a few years as the student population increases. This one of the most important criterion for electrical layout design is that the power distribution system should be designed keeping potential growth in mind.

Normally the loads on campus fall in the range of 5000 to 20,000 K.V.A and so selection of primary 13,000 K.V.A. would allow doubling of the initial electrical load without a commensurate increase in investment of electrical plant (Because load capacity in K.V.A. of any feeder is the product of current supplied and the system voltage). Since conductor sizes are determined by the current requirement and are proportional to the cost, higher voltages are generally economical where load is of sufficient magnitude.[7] Secondary utilisation voltage have generally been found to be most economical at 480 volts for academic buildings. For other buildings where fluorescent lighting is not essential we can use 120/208 voltage.

---

7. 'Campus Planning' Electrical Systems, page 42
Walter J. Fleck
Building Systems Design, July, 1971.

Distribution Systems:

Feeder:

A feeder in a distribution system is generally defined as a circuit carrying power from a main sub-station to a secondary sub station.

Distributor:

It supplies power to individual consumer.

The distribution system is comprised of a net work of feeders and distributors together with their associated substations containing switchgear and transformers.

Different distribution systems are

a) Radial system

b) Parallel system

c) Ring system

a) Radial System:

The radial syston requires a number of cables each running separately from the intake position to the individual buildings and so it is not economical and suitable for a new growing campus. See plate 15, Fig.A.

b) Parallel system:

In this system two wires are taken from the sub-station to the building. Though it is called parallel

system these two lines generally follow different routes so that in case of failure of one line current can be tapped from the another line. Though it is costly method than radial system, it has more advantages over it.

c) Ring System:

In ring system one heavy cable passes round the whole site in the form of a ring and the supply to each separate building is tapped from it. Generally it is more economical than a radial system for a campus electricity supply. It has another advantage in that, with the addition of buildings in the future, it is easy tap the current. Also voltage drop can be considerably reduced. See plate 15, Fig.C.

Cables:

Cables used for distribution systems are:

a) Copper cables
b) Lead cables
c) Aluminium cables
d) P.V.C. cables

Initially copper, lead cables were used as conductors but they are now replaced by Aluminium cables. Jointing

Distribution Systems:

Feeder:

A feeder in a distribution system is generally defined as a circuit carrying power from a main sub-station to a secondary sub station.

Distributor:

It supplies power to individual consumer.

The distribution system is comprised of a net work of feeders and distributors together with their associated substations containing switchgear and transformers.

Different distribution systems are

a) Radial system

b) Parallel system

c) Ring system

a) Radial System:

The radial system requires a number of cables each running separately from the intake position to the individual buildings and so it is not economical and suitable for a new growing campus. See plate 15, Fig.A.

b) Parallel system:

In this system two wires are taken from the sub-station to the building. Though it is called parallel

PLATE No. 15

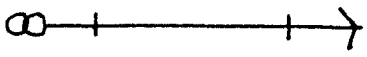


FIG-A RADIAL SYSTEM

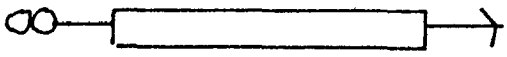


FIG-B
PARALLEL

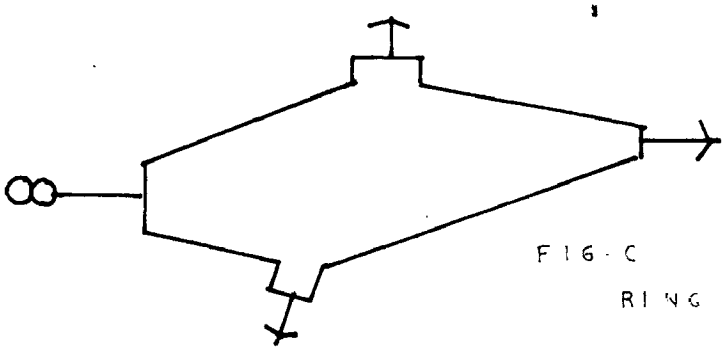


FIG-C
RING SYSTEM

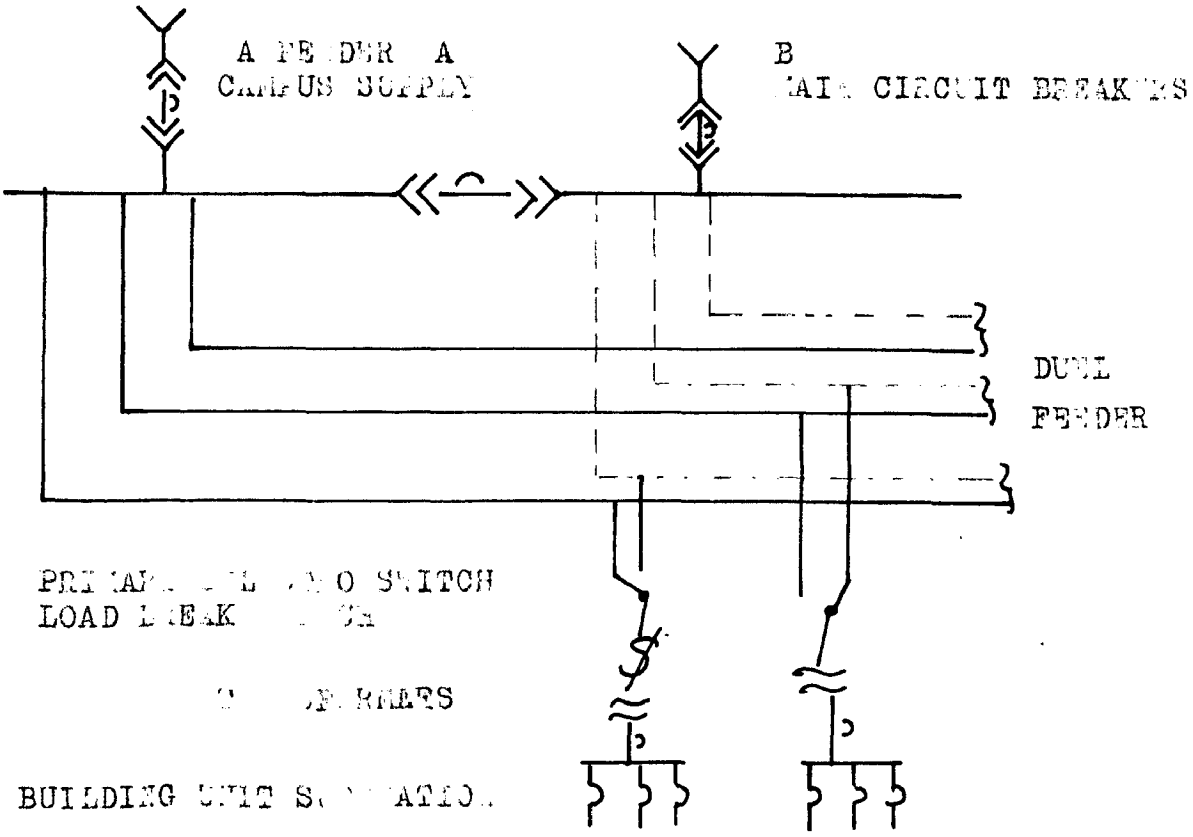


FIG D PRIMARY SELECTIVE
RADIAL-SYSTEM.

ELE. DISTRIBUTION SYSTEMS.

'Fig.D 'Campus Planning' Ele. System, page 43
.J. Fleck
Building Systems Design, July 1971.

system these two lines generally follow different routes so that in case of failure of one line current can be tapped from the another line. Though it is costly method than radial system, it has more advantages over it.

c) Ring System:

In ring system one heavy cable passes round the whole site in the form of a ring and the supply to each separate building is tapped from it. Generally it is more economical than a radial system for a campus electricity supply. It has another advantage in that, with the addition of buildings in the future, it is easy tap the current. Also voltage drop can be considerably reduced. See plate 15, Fig.C.

Cables:

Cables used for distribution systems are:

a) Copper cables
b) Lead cables
c) Aluminium cables
d) P.V.C. cables

Initially copper, lead cables were used as conductors but they are now replaced by Aluminium cables. Jointing

method in case of aluminium is complicated than lead cable, hence some times lead cable is preferred.P.V.C. cables are suitable only for low voltages as they are likely to deteriorate at continuous operating temperatures over 70°C and to melt or lose shape if subjected to over loads. The minimum bending radius for cable upto 11 K.V. is 12 times diameter and for 33 K.V. it is 20 times diameter.

Primary Selective System for a Growing Campus[8]

This system employs dual primary feeder circuits, each of which normally carries half the load of the circuit but it has the capacity to carry the entire circuit load if needed. Feeder selection is done at the utilization transformation substation. In addition to increasing system reliability by providing break up primary feeders at a reasonable invested cost, this type of system is particularly suitable to campuses where new construction is prevalent and feeder shut down is frequent. See plate 15, Fig.D.

---

8. 'Campus Planning' Electrical system, page 43
Walter, J. Fleck
Building Systems Design, July, 1971.

4.4 Air Conditioning:

In our country air conditioning for a campus is not practised due to poor economical condition. In some cases cooling is practised that too for few buildings and not for the whole campus. If financial conditions permit, then for a University Campus, application of centralized control system is ideal. In a campus, a number of buildings are tied to a single console and thus there is saving as compared with a single building air conditioning. Console should be located at the central Air Conditioning Plant. The size, location and a age of buildings have also to be considered.

This system was first practised in Harward University Campus[9] where 67 buildings were connected with centralized system. Centralization provides flexibility and economy where the tunnel runs underground. This system is not only limited to large campuses but can also be used for small colleges and campuses.

Concluding Remarks:

To make the layout of these services most economical maximum advantage of natural slope should be taken. The layout should have flexibility for changes occur during

---

9. 'Centralization of Campus Control' page 39
Air Conditioning, Heating and Ventilation, July, 1967.

construction period. Topography, subsoil conditions, availability of municipal services should be thoroughly studied.

For cold water supply P.V.C. pipes are economical and have better qualities than traditional material pipes. Electrical services should be designed in consideration with future load demand, making provision for flexibility and future wiring. So oversize cable trays, over size underground ducts are usually a wise investment.

A very important aspect which must be considered is the timing of utilities relative to building construction. Wherever possible underground services should be installed in advance before building construction starts. In this way the interference by open trenches to the vehicles will be minimised. All these services should run through an underground tunnel or utility coridor, so that installation and maintenance is not a problem.

Part 3: Campus Development

C H A P T E R V

HORIZONTAL AND VERTICAL DEVELOPMENT OF UNIVERSITY CAMPUSES

Present trend of campus development is to acquire hundreds of acres of land near a town or a city, with a minimum compensation and to develope a part of it for the present use while the rest of the site is kept for future expansion. This site is unutilised for long time. The campuses are horizontally spread out. Generally buildings are two storied with more open spaces in between. In the initial stages land value may be less but it increases very rapidly as campus develops. Hence, wastage and under utilisation of land must be avoided. Over all economy can be achieved with following considerations.

a) Economy in land utilisation

b) Economy in construction and Services.

c) Minimisation in transportation.

5.1 Horizontal Development:

Urbanisation has made land one of the costliest commodities. This real estate is in continuous short supply. University Campuses developed in urban areas

uptil now, with few exceptions, have horizontal development and have occupied a vast expanse of land. The campuses are making further demand on urban land as they grow. In horizontal development best use of land is neglected also cost of external services increases due to horizontal development. This is discussed in detail in the next chapter. In old Indian campuses these services (sewer lines, electrical lines) were not available, also roads were all weather roads as science was not so advanced. So no consideration was given to these points.

The only advantage of horizontal development is the ease in construction and economy achieved in construction cost. From constructional point of view it is economical to have a two storied building rather than single storied or three storied and above.

5.2 Vertical Development:

Why go vertical:

Land is most precious in urban areas. Space is tighter than ever before in history, due to the ever increasing population. As a result urban buildings are more vertical than ever. Colleges and University buildings should also confirm to this.

Enrolment number of Universities is increasing

very fast every year, with an increasing proportion of students from lower and middle income group. Every academic institution campus has to provide facilities for them and so there is no way but to go vertical within the fixed area of land available. In urban areas either land is not available for further expansion or if available it is very costly which the institute can not afford. More over walking distance restricts horizontal growth, as it should not take more than 15 minutes to traverse it. Thus for future development of old campuses we must go vertical,also for new campuses we must go vertical in order to have more economic development and intensive use of land.

Our educational planners have not yet understood the land problem and necessity to make a compact campus. This can be further emphasized by the article of J.M. Richards on 'Designing of new Universities'[1].

These are not the days of thinking in terms of thousand acres for a University as in the case Nehru University so close to the metropolitan city of New Delhi. For a thousand acres land Abercrombie would have housed a population 1,20,000. Alloting this vast expanse of a

---

1. 'Designing of new Universities' page
J.M. Richards
Indian Architect, Feb., 1972.

land to a University can mean waste in the greatest assert man possesses - Land, more so near to a capital city, in addition to what this vast expanse of land will mean in terms of expenditure on services and time and expense consumed in travel within the campus.

Our excessive zeal is in reality our ignorance on the issue, will cost future generations astronomical sums in maintenance of these services, exasperation in travel, because improper use of land has been made. Technical Institutions built recently in India are sprawling campuses, students have to move on scooters and bicycles from department to department.

5.3 Some Economic Aspects of High Rise Buildings:

From economic point of view high rise buildings have enabled

a) A higher utilization of limited land.
b) Compactness in the arrangement.
c) Convenience through the proximate location of interacting uses - and so - easier communication.
d) Economy in services.

High rise buildings, if planned with proper consideration, are not only economical but also have other

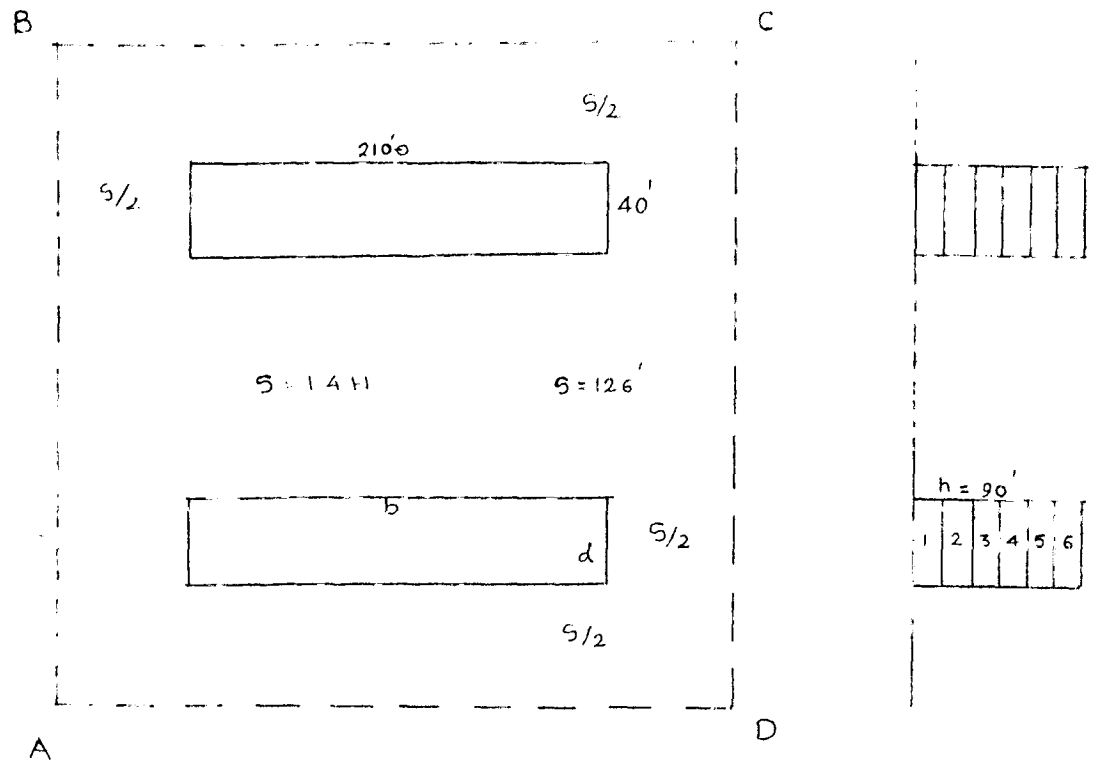


FIG-A BACK TO BACK

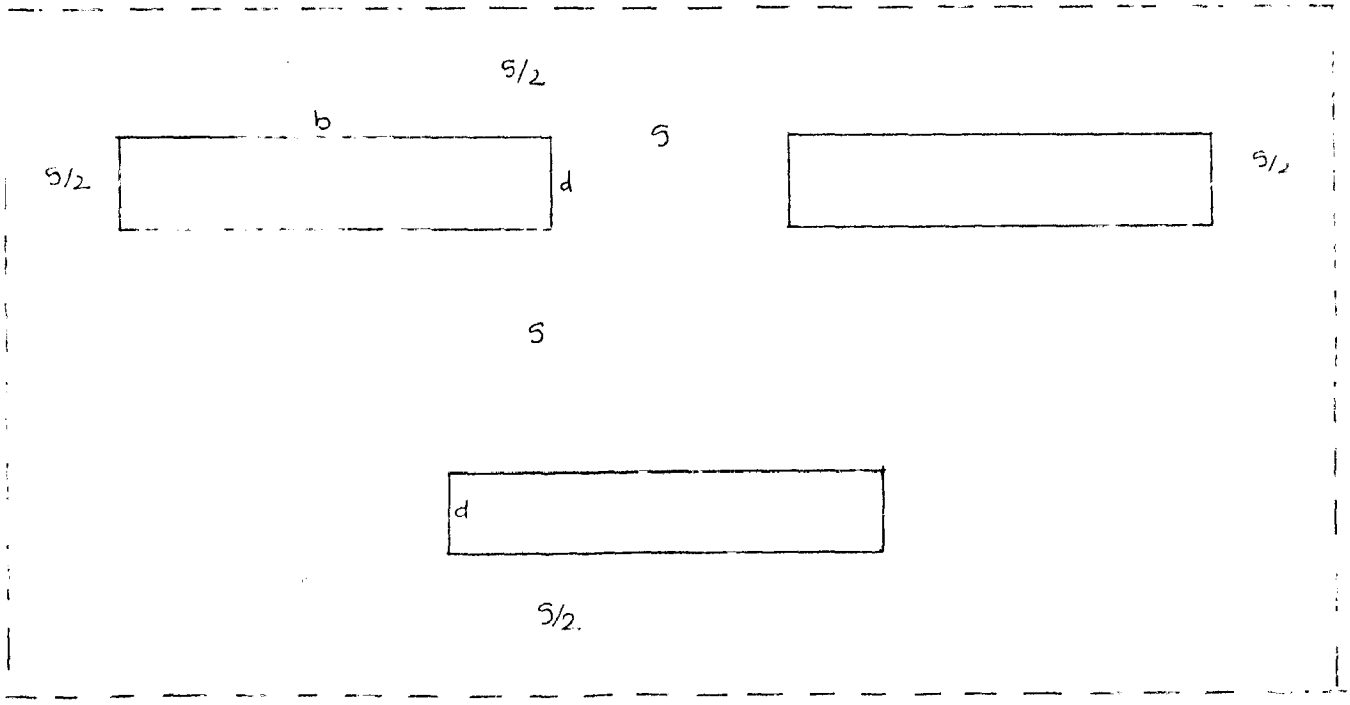


FIG -B STAGGARD GROUPING

GROUPING OF BLOCKS & PLOT-SIZE

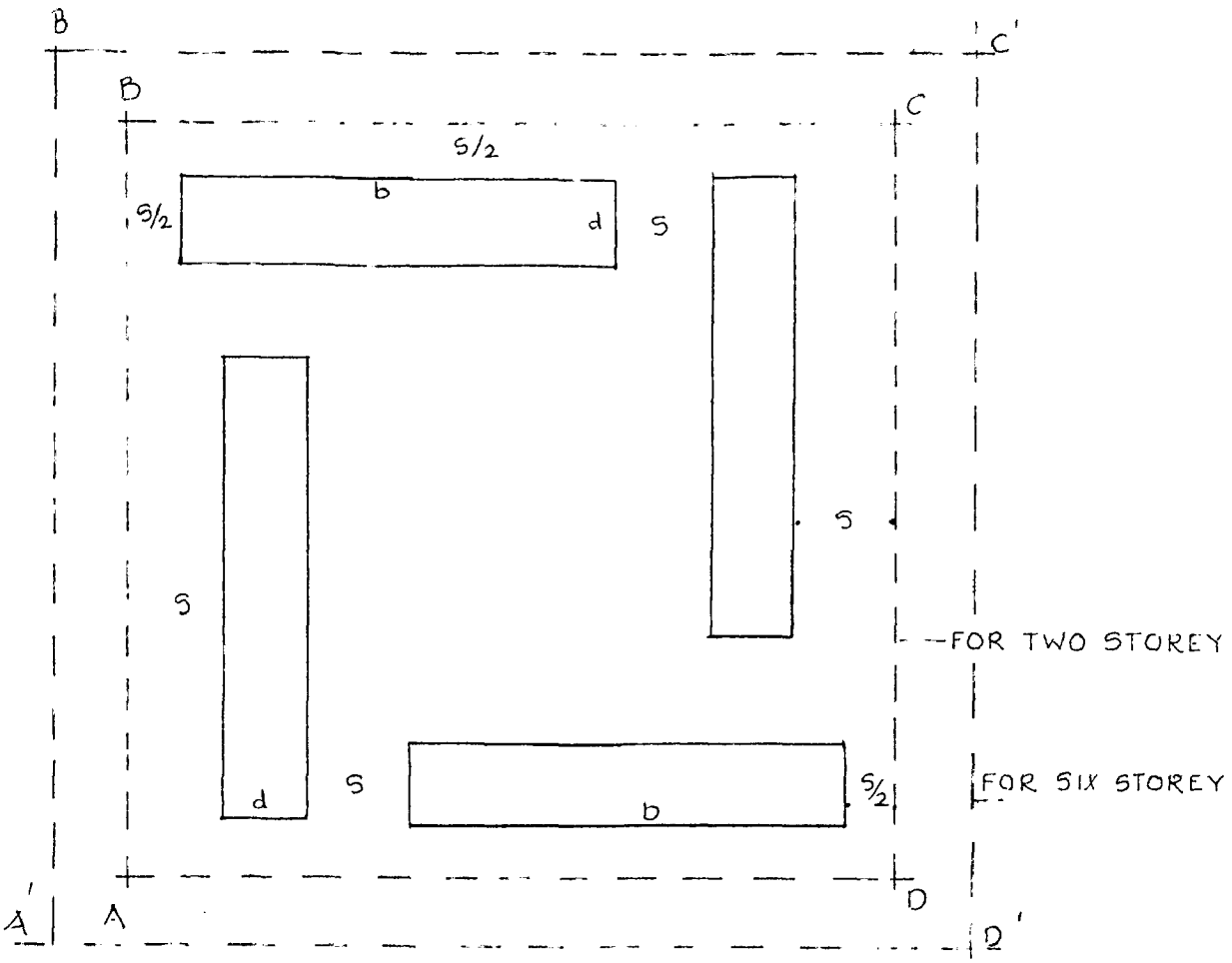
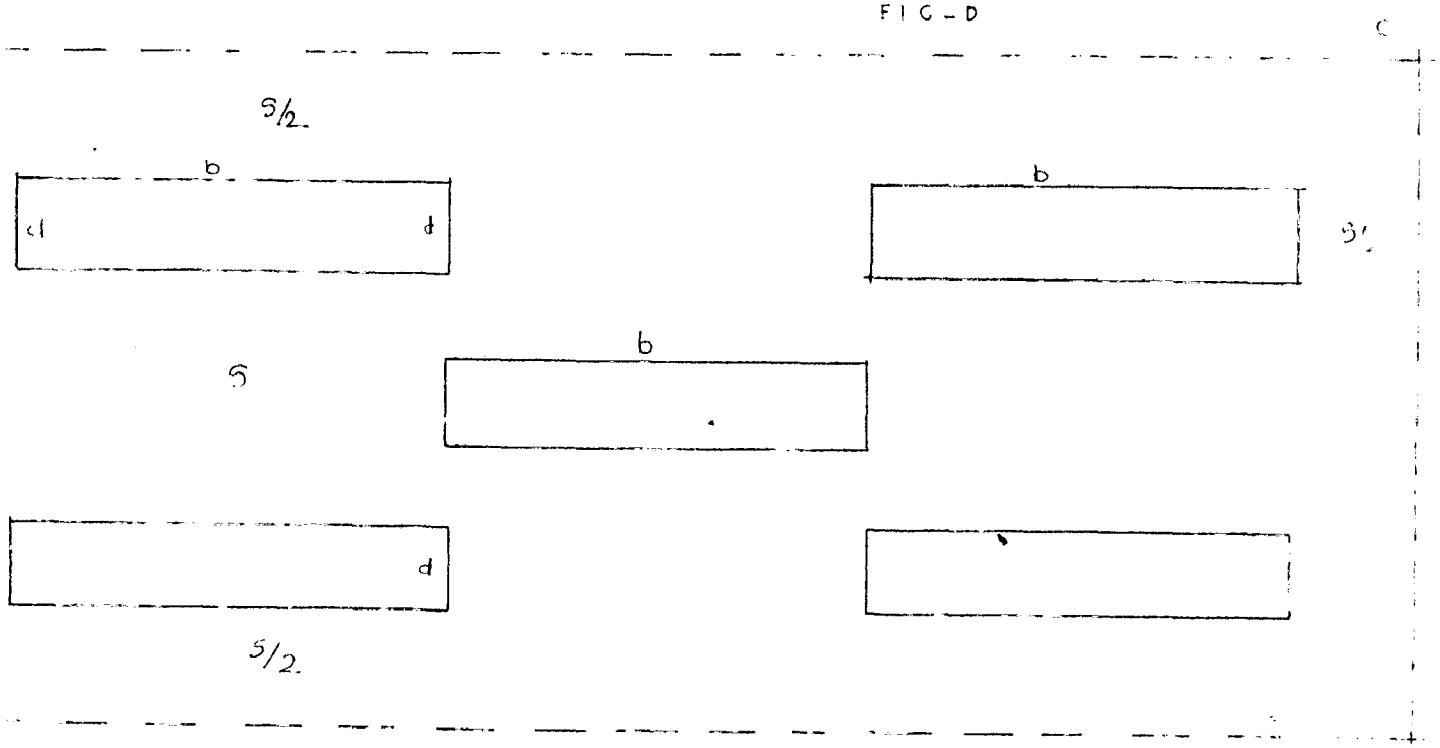


FIG-C

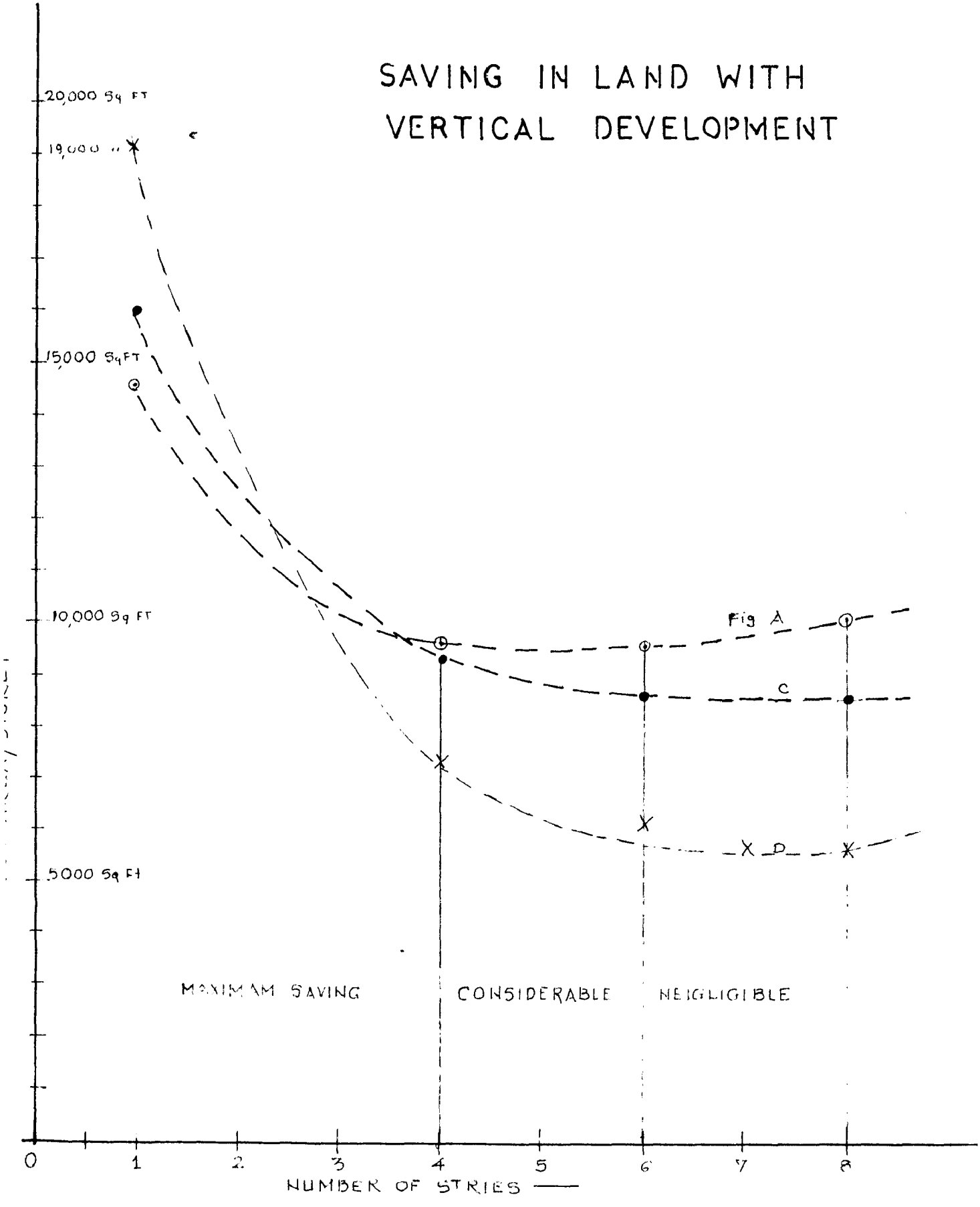
FIG-D



GROUPING OF BLOCKS & PLOT SIZE

PLATE NO. 18

SAVING IN LAND WITH VERTICAL DEVELOPMENT



advantages such as more sun in winter and less in summer, better air, freedom from noise and commanding views.

a) Economy in Land:

The space between blocks must have a definite relationship in scale with the buildings. The spacing of buildings is mainly guided by the angle plane of sun rays, location and climatic conditions. In a research carried out in C.B.R.I. it was found that[2] for Delhi region (29°N lattitude) 55° light plane gives minimum space between two blocks, for any orientation as S = 1.4 times the height. (allowing minimum two hours sun light from 11 a.m. to 1 p.m. on Dec.21st).

On this basis study of different groupings of blocks is done and saving in land with increase in number of stories is calculated here under. See the plate Nos. 16 and 17 and the graph of number of stories vs plot area per story required on plate No.18.

From the graph it is clear that area of plot per story decreases sharply from 1st to 4th storey, from 4th to 6th it is not so prominent and after 6th storey it is negligible.

---

2. 'Optimum Utilization of land for high density habitation' K.L. Datta and B.B.Garg Scientist, C.B.R.I., Roorkee

With vertical development a campus can be designed as compact one so that activities common to various departments can be located near to them. Another advantage is that communication is easier in this case.

&) Economy in Services:

This will be discussed in detail in the next chapter.

5.4 Problems of high Rise Buildings:

a) Social Problems:

High rise buildings generate great deal of traffic at peak hours, after classes are over. In high rise buildings discipline tends to be segregated breaking the relationship from one floor to another. Architects like C.A. Doxiadis are of the opinion[3] that construction of high rise buildings is an architectural crime as it spoils the nature and social contacts are also less. But on the contrary, a sociological study of high rise buildings in Chicago by Gerda Wekerle revealed that elevators work as public places, space inside elevator brings people together. Elevators serve as a communication net work.

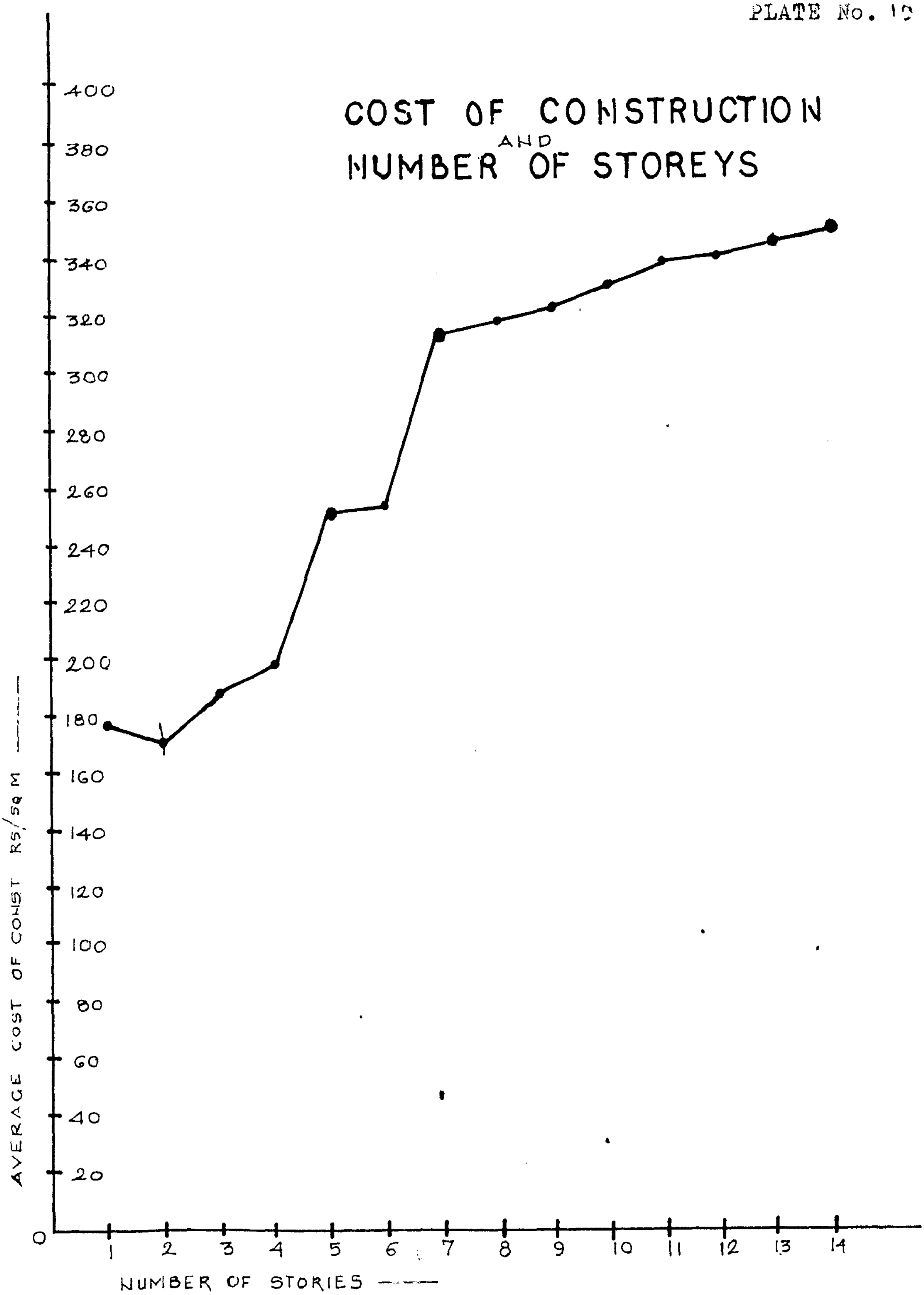
b)Increase in cost of Construction:

Cost of construction varies with the location, size of building, type of structure, general specifications,

---

3. 'High rise Living' page 196 Gerda Wekerle
Ekistics March 1972.

PLATE No. 12



'Interrelationships and Impact of different parameters in high density housing'

[illegible] Dutta and [illegible] Garg
Scientist, C.B.R.I., Roorkee
[illegible] Congress, 1957

internal services provided and number of storied. Keeping all the other variables same, cost of construction per storey has been calculated by C.B.R.I.[4] The figures show that cost of construction increases with the rising number of stories, except for two storey construction.

The increase in the average cost is marked by 5th 7th and 11th stories. (See graph on plate No.19 and Appendix III). This increase is due to additional internal services which are essential above 4th storey such as lifts, booster pumps for water supply, fire extinguishers and also change in type of construction i.e. from load bearing to frame structure. Single storey construction is fairly costly in all cases. These figures are calculated for dwellings butthe trend of increase in cost with number of stories will remain same for academic buildings also- except that cost figures will be changed.

In high rise buildings in addition to structures, lifts, refuse disposal, fire-hydrants add to the extras. Maintenance costs are also higher. Significant saving is done in roads, land required and external services. So pertinent question is which costs less? Space on the ground or the installation and use of services. If the cost of vertical transportation facilities works out to

---

4. 'Inter-relationship and impact of different parameters in high density living' page 40
K.L. Datta and B.B. Garg
Scientist, C.B.R.I., Roorkee
Design Incorporating Indian Builder, Oct., 1969.

be less than land value per unit area than it would be feasible to go vertical.

5.5 High Rise Trend in Campus Planning:

Vertical development of campuses is not a new thing to us. Even in our old campuses viz NALANDA, the over all development was vertical and planning was compact. On a site measuring 1 mile x ½ mile some 10,000 students and 1510 teachers were housed. Library building was 9 stories high while students dormitories were four stories high. But at present the trend is towards horizontal development and not vertical. In America the trend is towards high rise campuses, some of the newly developing campuses are given below.[5]

a) Borough of Manhattam Community College in New York is designing a high rise campus for 5000 students on 4½ acre site.

b) The University of Pennsylvania plans to acquire land in the air by purchasing or leasing the air rights and building a platform over the rail road yeards on the banks of the river 'Schuykill'. This new site will be used for a housing and recreation complex.

---

5. 'Campus in the City',
Report of Educational facilities laboratories.
E.F.L., New York.

c) At both the Milwaukee campus of the University of Wisconsin and the new south side campus of Chicago College, the air space over city streets will be employed as building sites.

d) New York city will build a 14 acre platform over a rail road yard to accomodate an entire new campus for 'Bronx Community College'.

e) Stevens Institute of Technology will be built over the waters of Hudson river, New Jersey. The water front has been selected as the site for major part of the academic complex and dormitory space will be floated up the river.

f) 'Rutgers University' is building the complex of an entire physical education complex on the roof of a projected public parking structure.

Another alternative is that of joint occupancy, the combination of University facilities and commercial or residential structure on the same site.

The search for space has laid some institutions underground. To retain open spaces on campus or to keep new buildings in scale with existing campus structures, these institutions have been burrying lecture halls, class rooms, libraries and even gymnasiums.

At Massachusetts Institute of Technology out of

nine buildings proposed, four will go upto twenty stories. Even campuses located arround the country with rural land values are arriving at a point where they too must consider a certain degree of high density desirable.

In our country this stage has been reached many years ago but has not been realized by the administrative and technical person and not implemented. Land problem is becoming more acute day by day and so to avoid future risk we must follow the present trend of vertical development and compact campus planning. Otherwise campus will spread too much and will be very costly to maintain. Some of the campuses designed on these lines are I.I.T., Delhi and Punjab University, Chandigarh.

After considering these points the first question that arises, is A. Is there a maximum size beyond which any University should not grow? Study was conducted at Hamilton College[6] in New York for this purpose. It was observed that the optimum size depends on social, academic, economic values and on the type of college. It is best not to fix rigid limits. A big University has some advantages viz more grants, attracts highly qualified

---

6. 'School Building Research'
Publication No.1008

staff and students.

b) Another question which follows this is: how high should the building be and how spread out the campus? This depends on land available and how high you want the students to go up, and how soon and how far you want them to move horizontally. But in general walking distance between residences and academic buildings should not be more than 15 minutes distance.

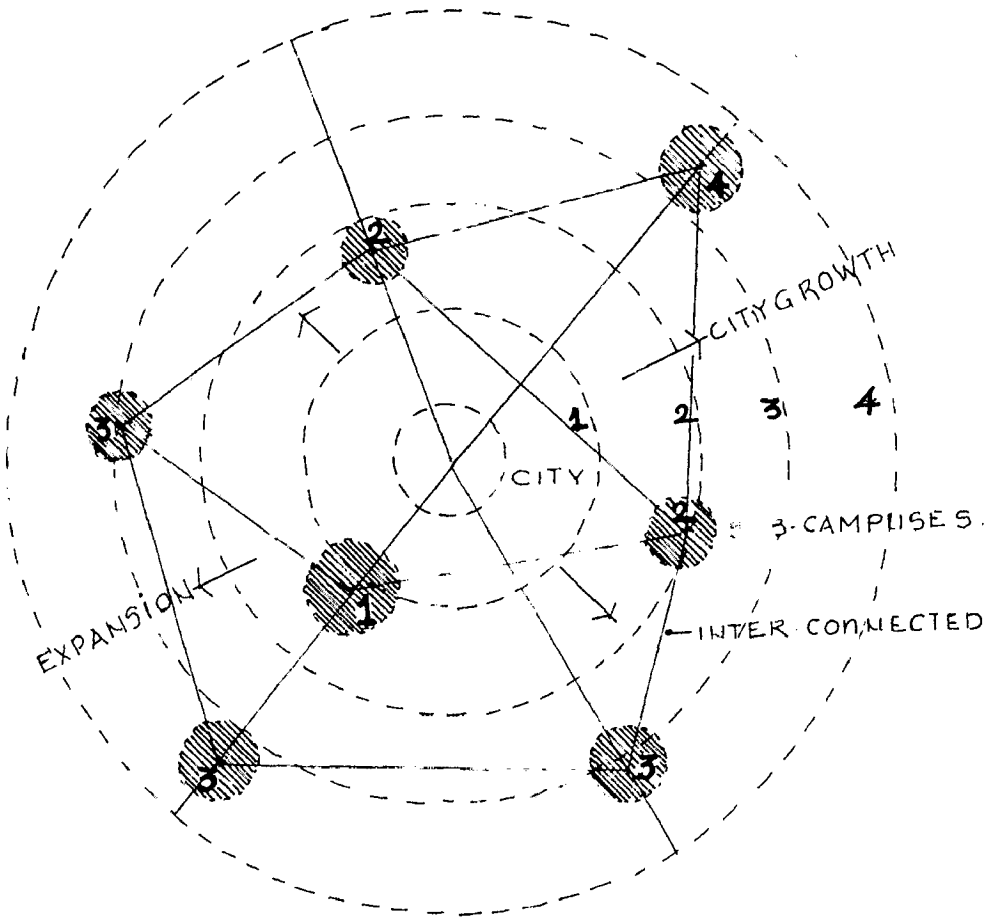
5.6 Multi Campus University:

The need to educate students near their homes, necessity to over come physical limitations on the growth of original campus and the availability of substantial land to develope new campus in specific areas have given rise to multi campus University.

This approach is used by the Pennsylvania state University in its campus.[7] It has 22 sub-campuses. Educational facilities and kind of courses decided as per local needs. Uniformity of programmes at all campuses and coordination among the campuses is a very important point to be considered. Flexibility for student to transfer from one programme to another is provided. Close

---

7. 'Engineering Education in Multi-campus University' page 308
N.J. Palladino
E.R. Weidhan
Engineering Education, Dec., 1969
American Society of Engineering Education.



MULTI CAMPUS UNIVERSITY

circuit T.V. systems connect all the sub campuses.

Some of the disadvantages of one campus type University as discussed earlier are minimised in this planning trend. Due to more number of sub campuses for one University, land acquired initially is not very much but only that much essential for the first phase. So each and every sq.ft. of the land is fully utilized from the begning. See plate No.20.

As enrolment number increases, new sub campuses are established. Location is decided as per the local need. These sub campuses are in the city and can be partly residential so that students may stay at their homes. Each campus has one director who controls it.

Concluding Remarks:

From the above cited study of campus developments, it is clear that the present trend of horisontal planning with open space for future expansion is not justifiable. We must design new campuses with compact planning and vertical dovelopment. Saving in land achieved upto 4 stories is maximum, from 4th to 6th is not so prominent, and after 6th it is negligible. Cost of construction increases with increase in number of stories. There is marked increase at 5th and 7th stories. So it is feasible

to construct academic buildings upto 4 or 6 stories as per requirement and land problem. Multi campus University is suitable for large Universities where site of main campus is small. And also suitable for those Universities which have close circuit T.V. to connect and coordinate all sub campuses. This saves the land problems, and also travelling distance from city to campus is reduced. This can be adopted for certain cases and not applicable to all Universities.

CHAPTER VI

IMPACT OF PLANNING ON COST OF EXTERNAL SERVICES

The cost of campus development is greatly influenced by the nature of planning, layout of services and the construction methods. Economy in planning depends upon the judicious use of these variables. Although the land prices and cost of construction bear heavily upon finance, the cost of services and site development also matters considerably. A proper choice of size of building block, grouping and number of stories with due regard to design and construction practices helps to achieve greater economy.

6.1 Impact on Cost of Roads:

In the analysis of following six different campus plans it can be seen that land utilised for roads varies from 7.5 to 28.5 percent of the developed land and it is maximum in 'Banaras Hindu University Campus' where planning is semicircular. Due to this road length increases and ultimately cost increases.

Areas of Road in different Campuses[1]

Sl. No.	Campus	Developed Site	Campus planning concepts	Areas of roads in acres	per-cent-age	Remarks
.	I.I.T., Delhi	320 acres	Sector planning	24	7.5%	Grid iron rpad pattern
.	I.I.T., Kanpur	523.4	Sector planning	75.2	13.0%	-do-
.	Banaras Hindu University	1088	Concetric Campus planning	311	28.57%	Radial road pattern
.	I.I.T., Kharag-pur	575.05	-	72	11%	-
.	Pantnagar Agricultural University	460	Concentric campus planning	85.36	18%	Radial road pattern
.	Vikram University	245.95	-	28.57	8.55%	-

1. University Campus Planning: Concepts and Standards
Thesis by M.C. Shah (1964)
School of Planning and Architecture, New Delhi

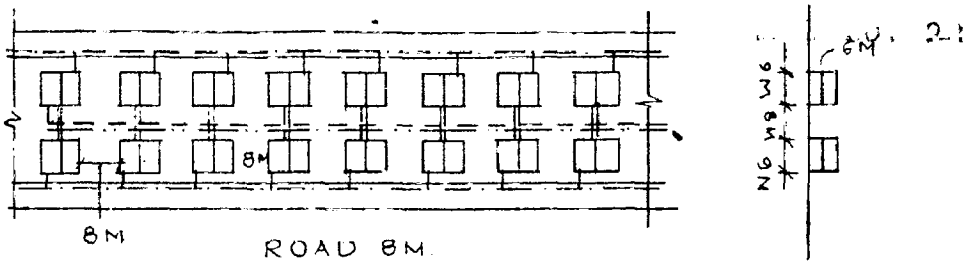


FIG A TWO STORIED

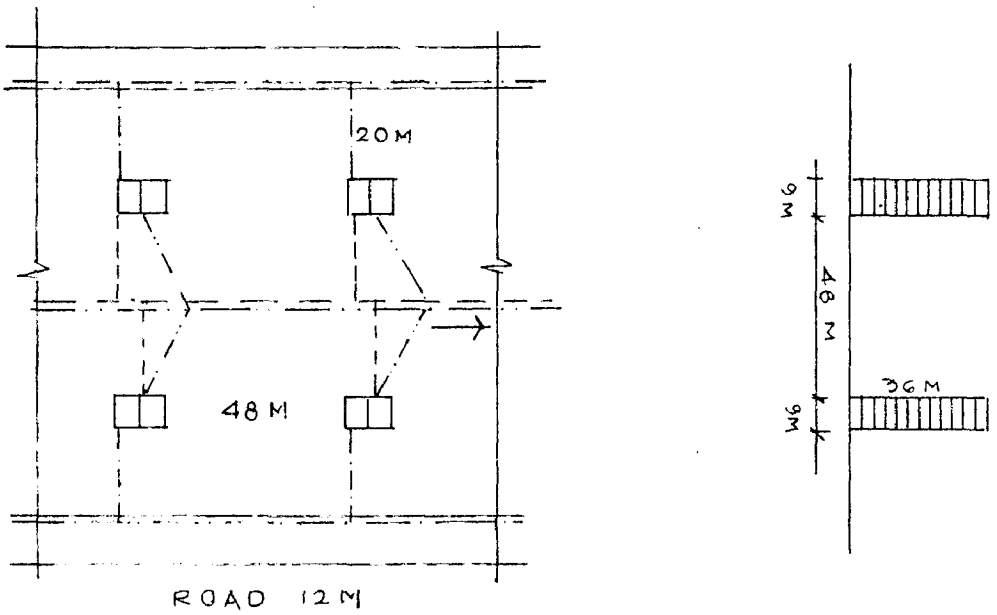


FIG B

X-GROUPING OF TWO UNITS

TWELVE-STORIED

ELECTRIC LINE

WATER LINE

SEWER LINE

LAYOUT OF SERVICES FOR DIFFERENT GROUPING

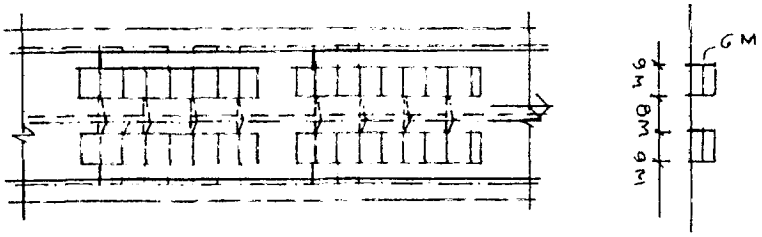


FIG -- C

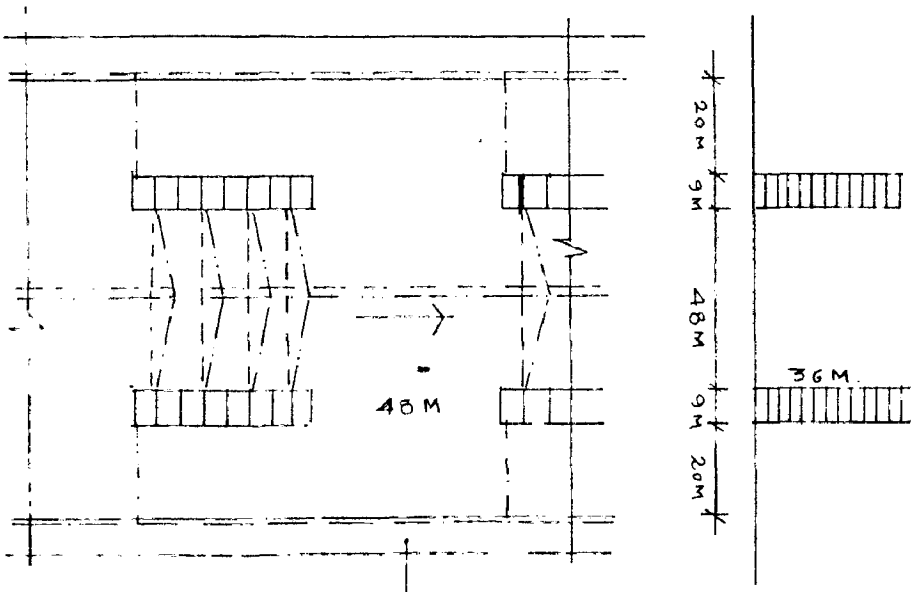
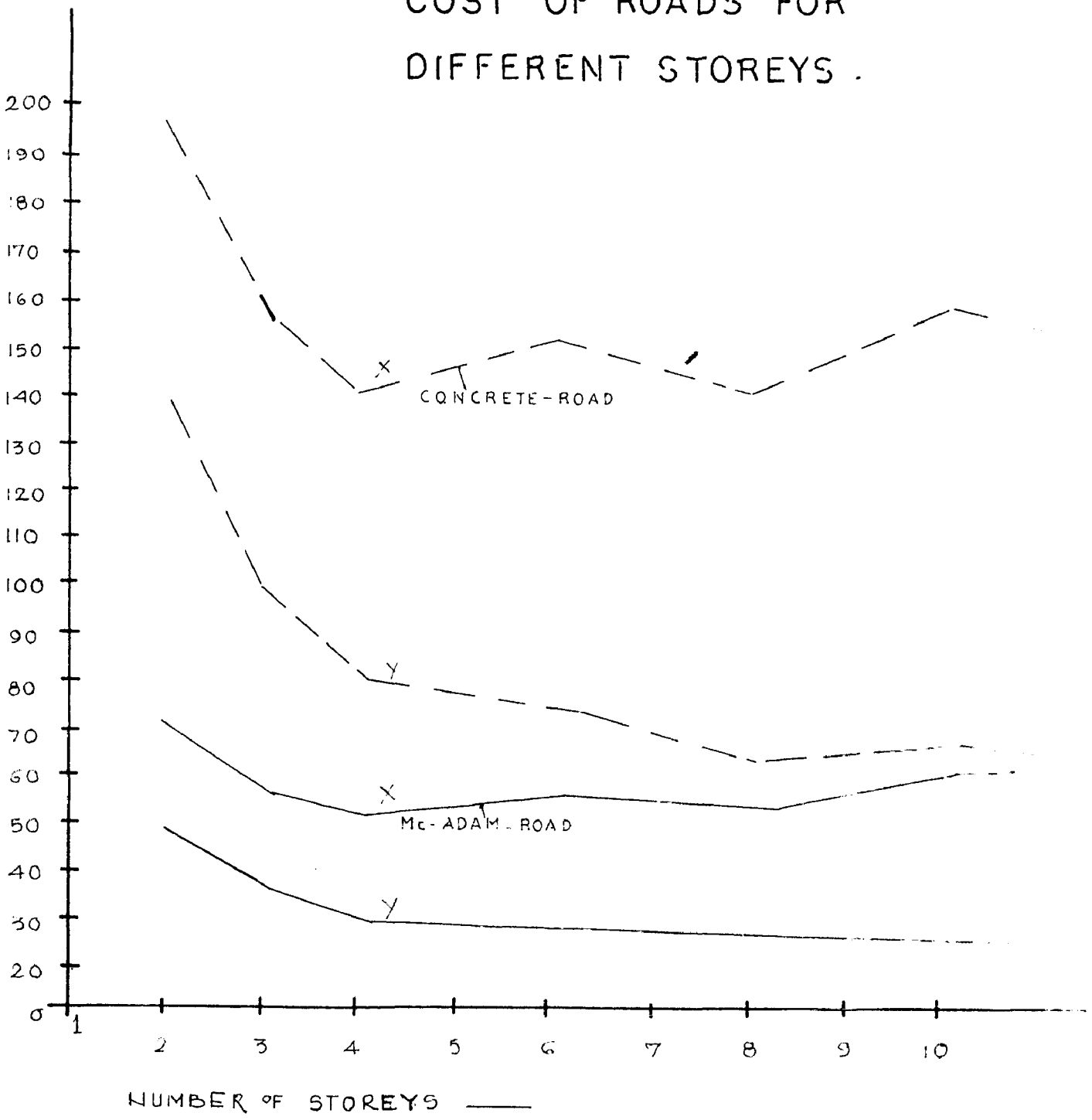


FIG - D

Y--GROUPING OF EIGHT UNITS

LAYOUT OF SERVICES FOR DIFFERENT GROUPING

COST OF ROADS FOR DIFFERENT STOREYS.



Generally the cost of roads reduces with vertical development although in some cases it rises again beyound eight stories (See graph on plate No.23). In research work of C.B.R.I.[2] it is observed that the cement concrete road costs Rs.197 per unit for two storey semi detached development and for Mc-Adam road Rs.69 only where as for twelve storey semi-detached development it reduces to Rs.150 and Rs.59 respectively.

An eight storey development gives the least cost in most of the cases. It has been observed that two to four storey dwellings cost more than high rise development. The cost can be reduced by above 32 percent of a two storied development where higher development can be adopted in view of other planning considerations. Though these results are for dwellings, the same results are applicable to campuses also.

6.2 Cost of Sewer Lines:

Generally the cost of sewer lines per unit decreases with increasing number of stories. The reduction is prominent in lower development i.e. from first to sixth storey and it decreases progressively beyound eight stories.

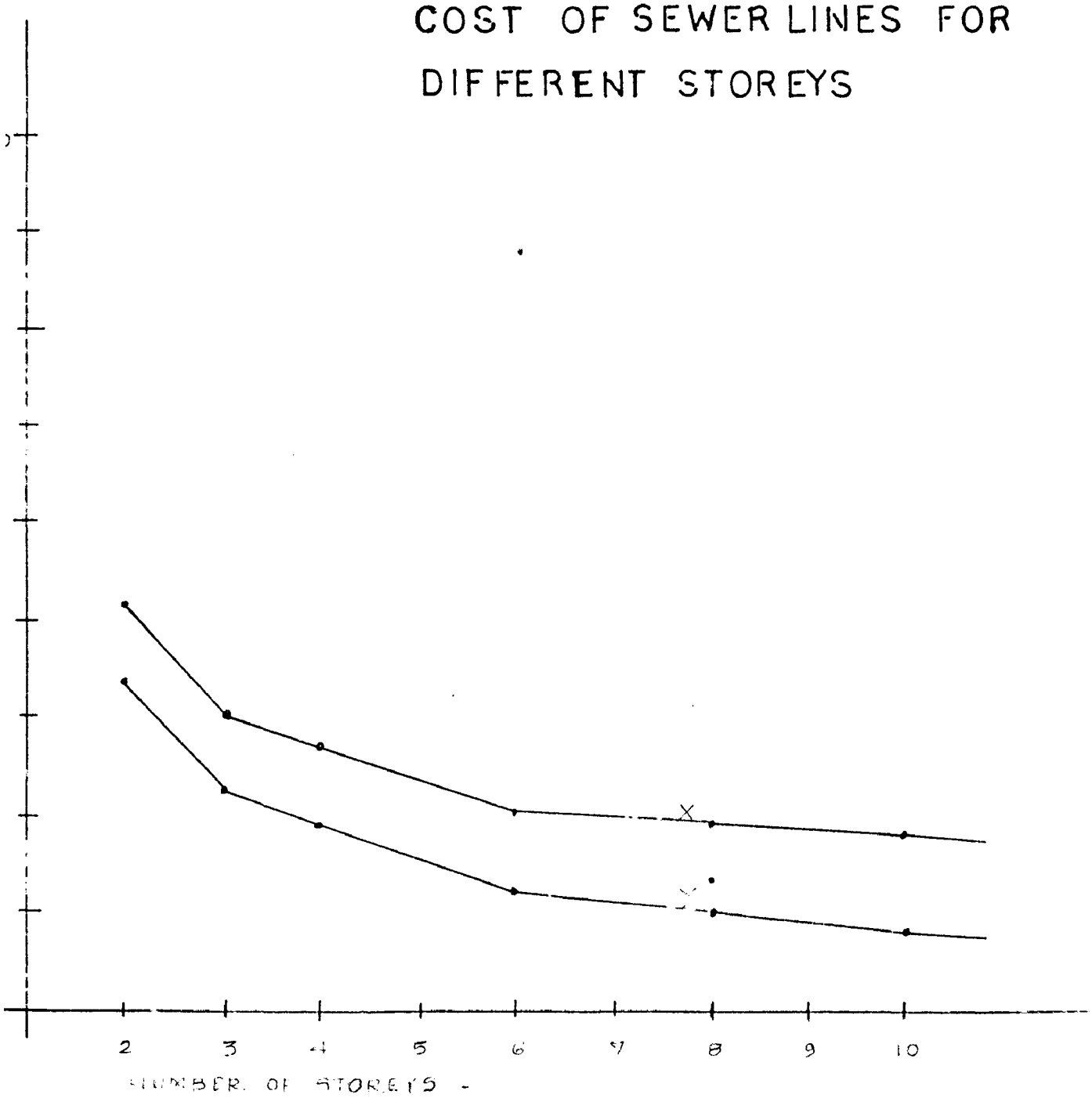
---

2. 'Impact of Planning on Cost of services'

K.L. Datta and B.B. Garg

Research Paper published in 'Civil Engg. Construction and Public Works Journal' Nov.-Dec.1968.

COST OF SEWER LINES FOR DIFFERENT STOREYS



(See graph on plate No.24). In a two storey semi-detached development the sewer lines cost[2] Rs. 105 per dwelling of size 6M x 9M which reduces to Rs.53 per dwelling in a case of twelve storey development. The cost increases with size of dwellings and the relative difference diminishes in case of high rise development.

Comparison of Costs of Roads and Sewer Works:

Cost of these services is also affected by the planning concept. In U.K. a study of costs of roads and sewer work with different planning concepts viz Radburn planning as against traditional planning was done for the same area. Same number of four storied flats have been considered and costs per unit of accomodation calculated. It was observed that cost varies as follows.[3]

---

2. 'Impact of Planning on Cost of Services'
K.L. Datta and B.B. Garg

Research Paper published in 'Civil Engg. Construction and Public Works Journal' Nov.-Dec., 1968.

3. 'Planning for Man and Motor' page
Paul Ritter

Pergamon Press: Oxford

Planning Concept and Cost of Services

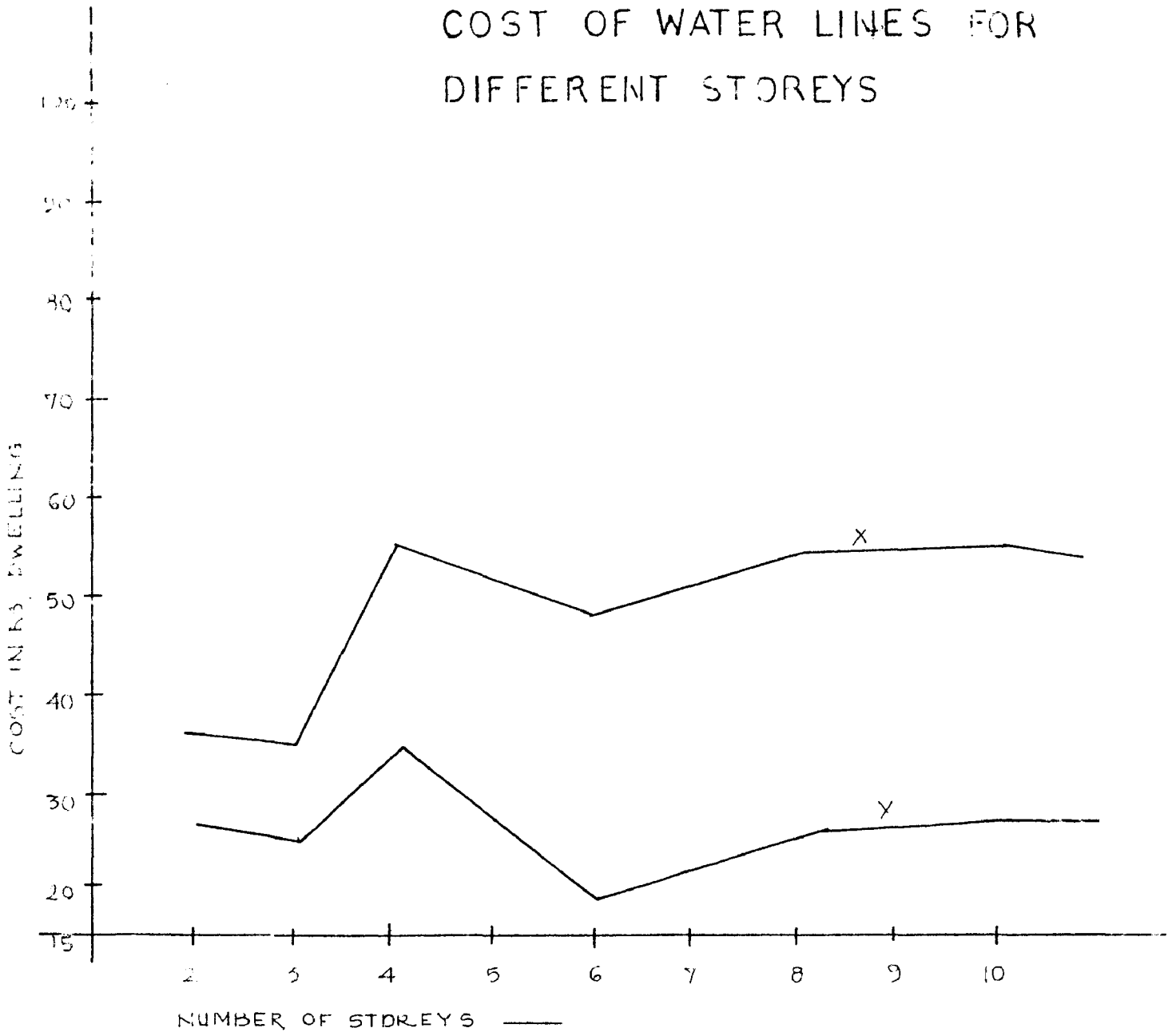
Sl. No.	Services	Radburn planning	Traditional Planning
a)	Roads and garages	18714	20180
b)	Foot paths	4594	3633
c)	Sewers	4355	4076
d)	Gulleys and Connections	920	903
e)	Sewer, ducts	247	346
f)	Lighting	2200	1705
		31030 £	30840 £
g)	Contingencies 10/ of above	3103	3084
	Total:	34133 £	33924 £
h)	Total number of houses	258	216
i)	Total number of flats (4 storey)	48	48
j)	Total units of accomodation	306	264
k)	Cost per unit of accomodation	111 £	128 £

Thus it is clear that planning reduces the over all cost by reduction in cost of services without losing feeling of spaciousness and good circulation.

107529

...RAL LIBRARY UNIVERSITY OF ROOR...
...KEE.

COST OF WATER LINES FOR DIFFERENT STOREYS



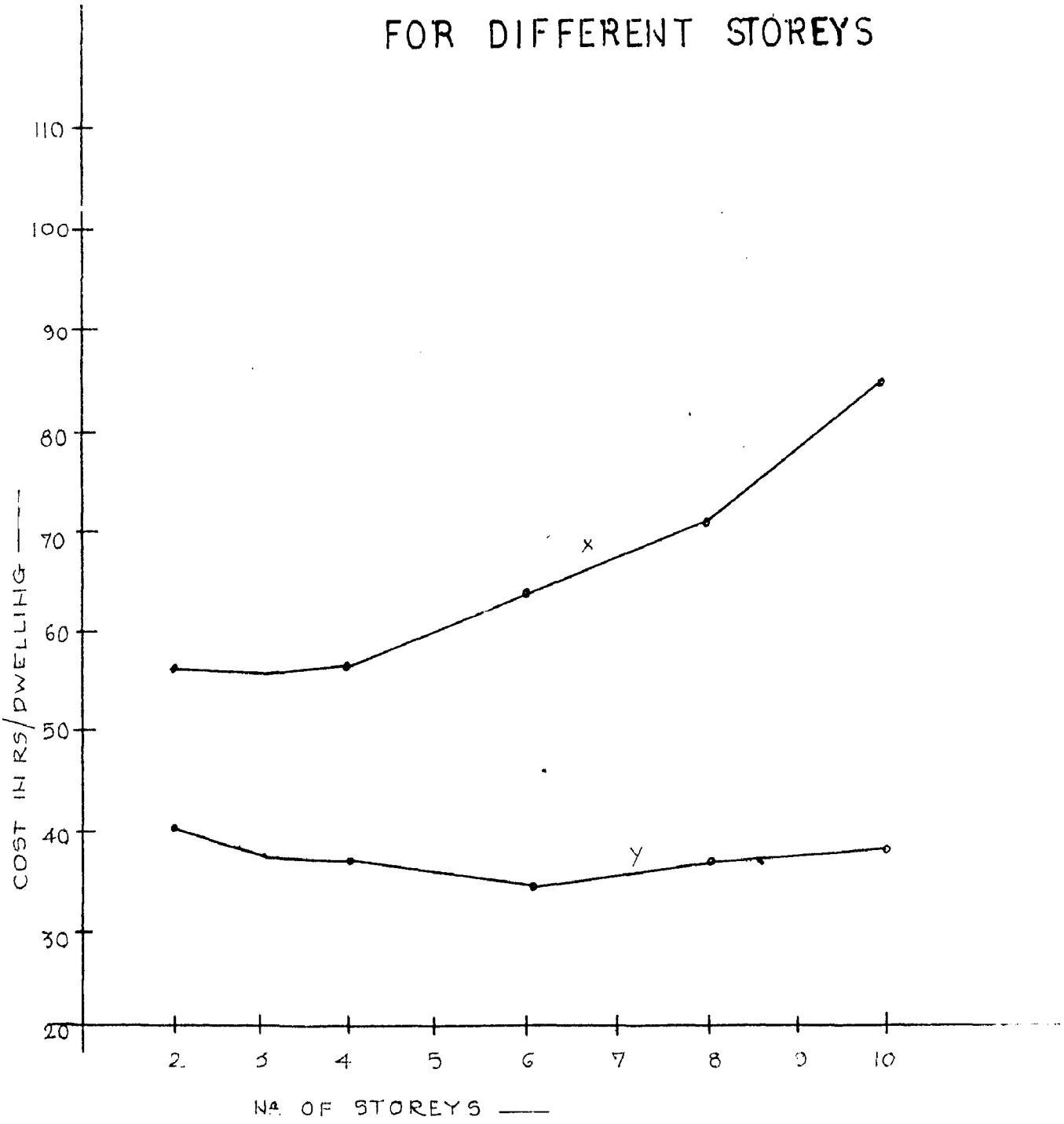
6.3 Cost of Water Lines:

Cost of water lines rises abruptly for four storey development, beyound 4th storey the cost record the lowest for six storeys and it increases steadily beyound this in most cases (See graph on plate No.25). For four storey development water head available is reduced due to frictional losses which does not affect developments beyound this since booster pumps are used. Cost of water lines are also affected by the planning concepts and compactness in design.

6.4 Cost of Electric and Telephone Lines:

Cost of these services reamins fairly constant upto four storeys and there after it rises uniformly upto eight storeys. This again will vary with size of building its planning and grouping. The cost increases for ten to twelve storied development. The cost of electric lines as per C.B.R.I. research per dwelling rises from Rs.56 to Rs.104 in case of twelve storey development as compared to two storey development for three phase lines. The cost of telephone lines also varies in the same way. (See graphs on plate No.26).

COST OF ELECTRIC LINES FOR DIFFERENT STOREYS

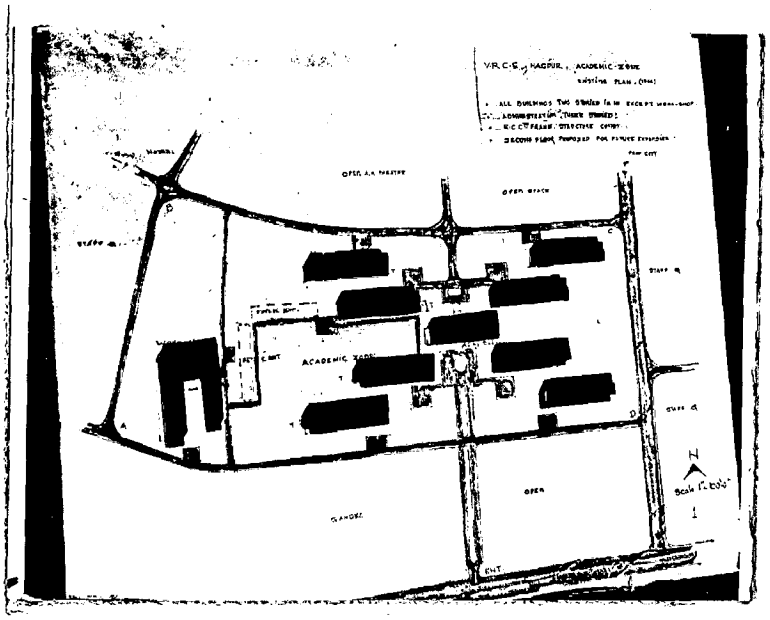


6.5 Economy in land and external services with vertical Development: Model Study of academic zone V.R.C.E. Campus, Nagpur.

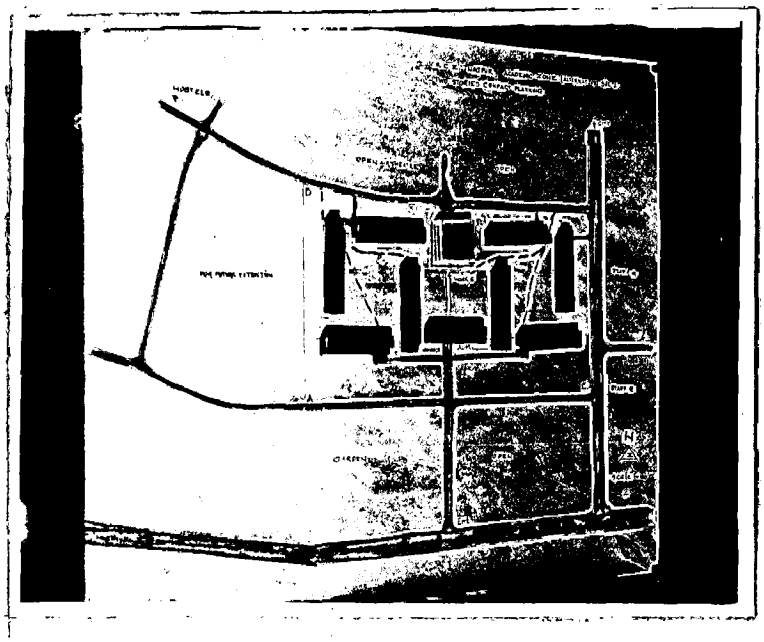
A further detailed study of these aspects is done by the application of theoretical basis above, to the academic zone of V.R.C.E. Campus, Nagpur. For the sake of study the same requirements and building blocks are considered and different solutions with variations in height and different planning concepts are worked out. (See plate No.27 and 28). Minimum land required and lengths of external services in each case has been calculated (See the table on page No.83).

It is observed from this model study that saving in land achieved is maximum upto four storey development i.e. 60' height. Afterwards a very negligible saving may be achieved. Lengths of roads, pedestrian paths, underground services are also minimum in case of four storey development than two storey and six storey developments.

PLATE NO. 27

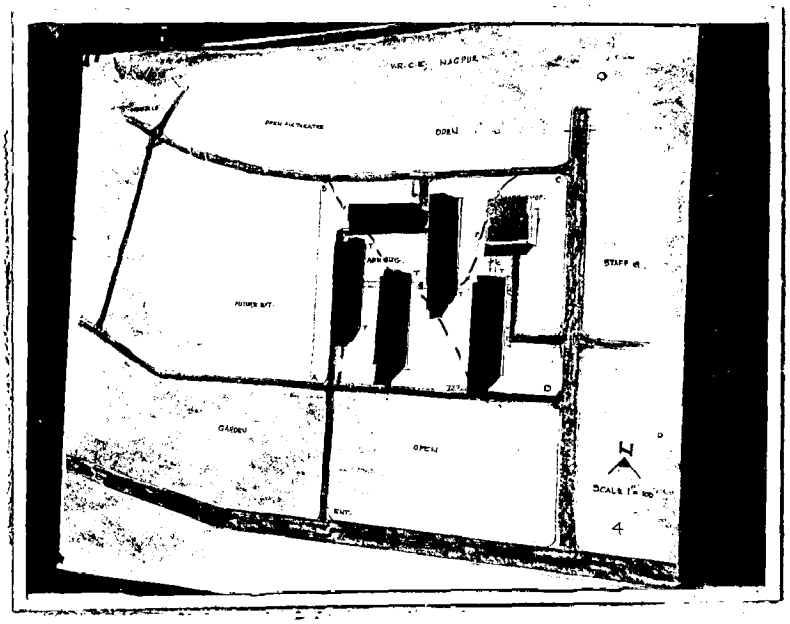


EXISTING HORIZONTAL SPREAD-OUT PLANNING. V.R.C.E. NAGPUR.



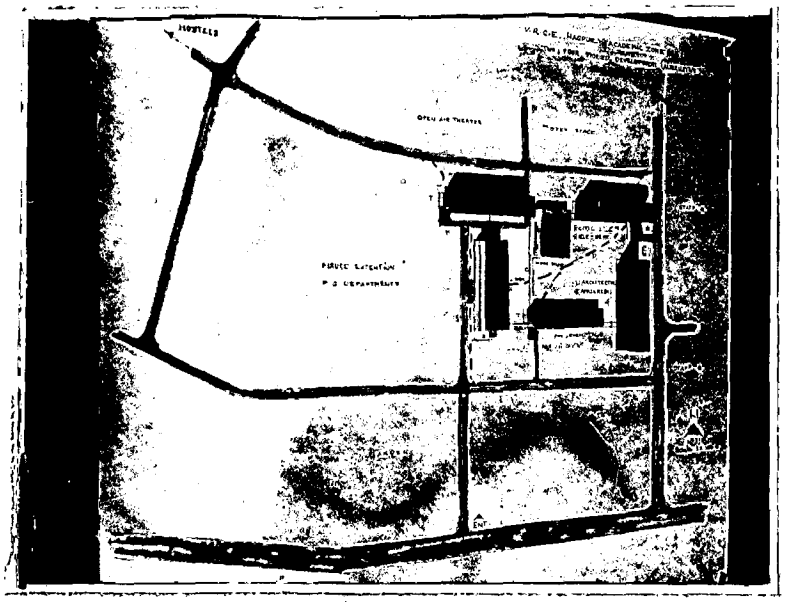
ALTERNATIVE GROUPING.
TWO STORIED COMPACT PLANNING.

PLATE NO. 28.



TWO AND FOUR STORIED DEVELOPMENT.

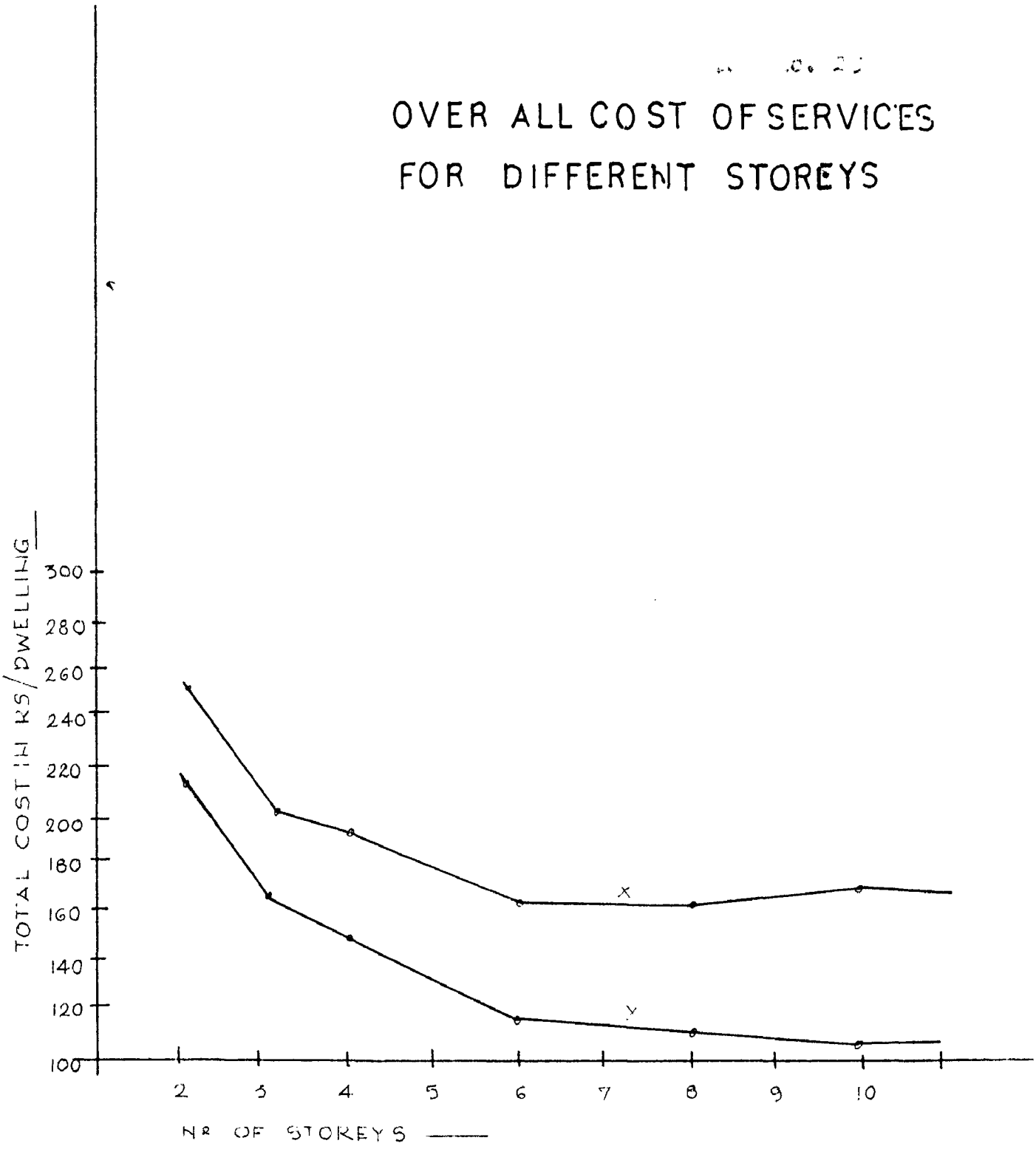
ECONOMY IN LAND AND SERVICES.



ALTERNATIVE GROUPING

MORE COMPACT PLANNING.

OVER ALL COST OF SERVICES FOR DIFFERENT STOREYS



Concluding Remarks.

Thus it is clear that cost of external services can be reduced with proper consideration to planning (grouping of blocks, its dimensions and vertical development) which will ultimately give economy in campus development.

From the table and graphs it is clear that over all the cost of services is higher for two storey development and reduces as it goes vertical. The slope of the curve is more in the range of two to six stories and it is very small in six to twelve storey region (See the graph on plate No.29). Thus in the vertical development upto six stories the economy achieved is very much than in twelve storey development. The golden mean can be achieved after consideration for land availability, its cost and constructional cost for vertical development.

Cost analysis of external services in University campuses is studied in detail in the next Chapter.

CHAPTER VII

COST ANALYSIS OF SOME NORTH INDIAN CAMPUSES

In 19th century campuses, as science was not so advanced, services and development were not considered while planning a campus. But now we must give proper consideration to these points to fulfil the present and future requirements.

A survey of few newly developed campuses was conducted to study their external services and development. The campuses studied were:

1) Indian Institute of Technology, Delhi
2) Indian Institute of Technnology, Kanpur.
3) Punjab University, Chandigarh.
4) Punjab Agricultural University, Ludhiana.

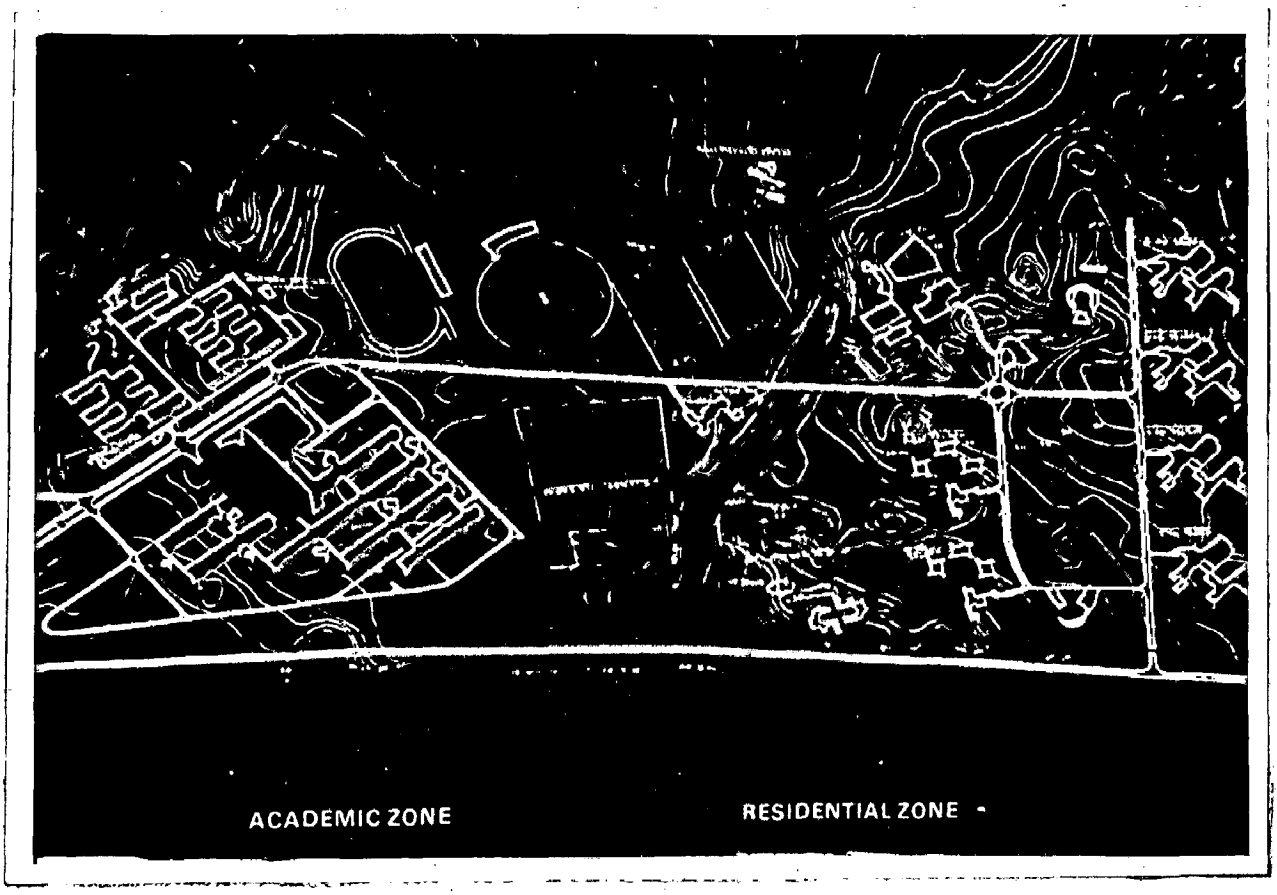
The external services considered here are roads, storm water drainage, sewers, watersupply and electrical lines. This study and cost analysis is based on the information supplied by the concerned authorities.

7.1 Indian Institute of Technology, Delhi:

Year of establishment in 1963

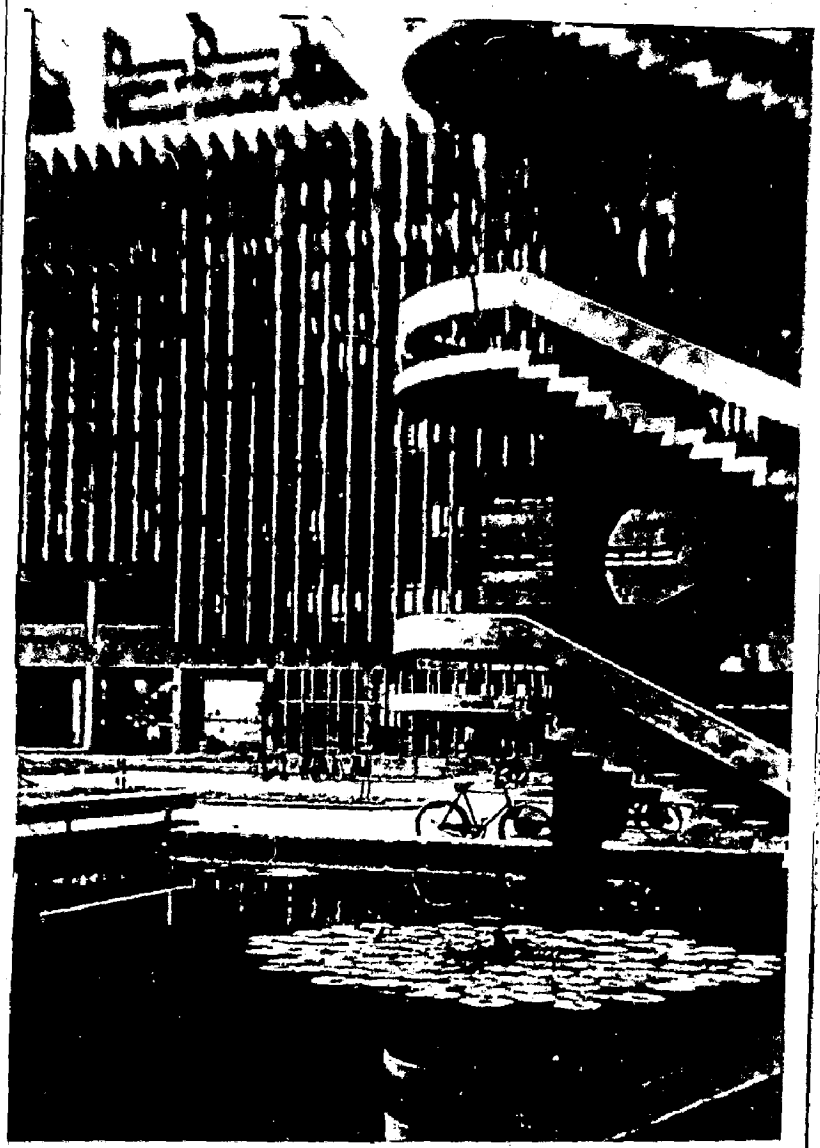
Site and location: Area 320 acres (including unused areas of Malas). Near Hauz-Khas, New Delhi.

PLATE NO. 30



I.I.T. DELHI, ACADEMIC ZONE -
COMPACT PLANNING.

PLATE No. 31



I I T DELHI, multi story academic building which dominates the center of the campus all departments are linked together in this complex.

VERTICAL DEVELOPMENT_

A NEED OF THE DAY.

ACADEMIC BUILDING. I.I.T. DELHI

Enrolment number: 2000 students.

External services in Campus:

Campus is planned in four zones:

i) Academic zone

ii) Residential for staff

iii) Residential for students and

iv) Leisure

Vehicular roads run straight whereas pedestrian paths follow the topography of the site. Academic zone is free from vehicular traffic and parking is provided on the outskirts. Other services are underground. Cost analysis of these services is done in table number 2 and 3.

Development of the Campus:

Academic buildings are three storied except administrative building which is seven storied. Residential buildings are four storied. All construction with R.C.C. frame structure.

Academic and residential zone have compact planning Much open space is left in between Academic and Hostel zones. This may be due to the Nala passing between the two zones (See plate No.30 and 31). This campus could have been made more compact than the present.

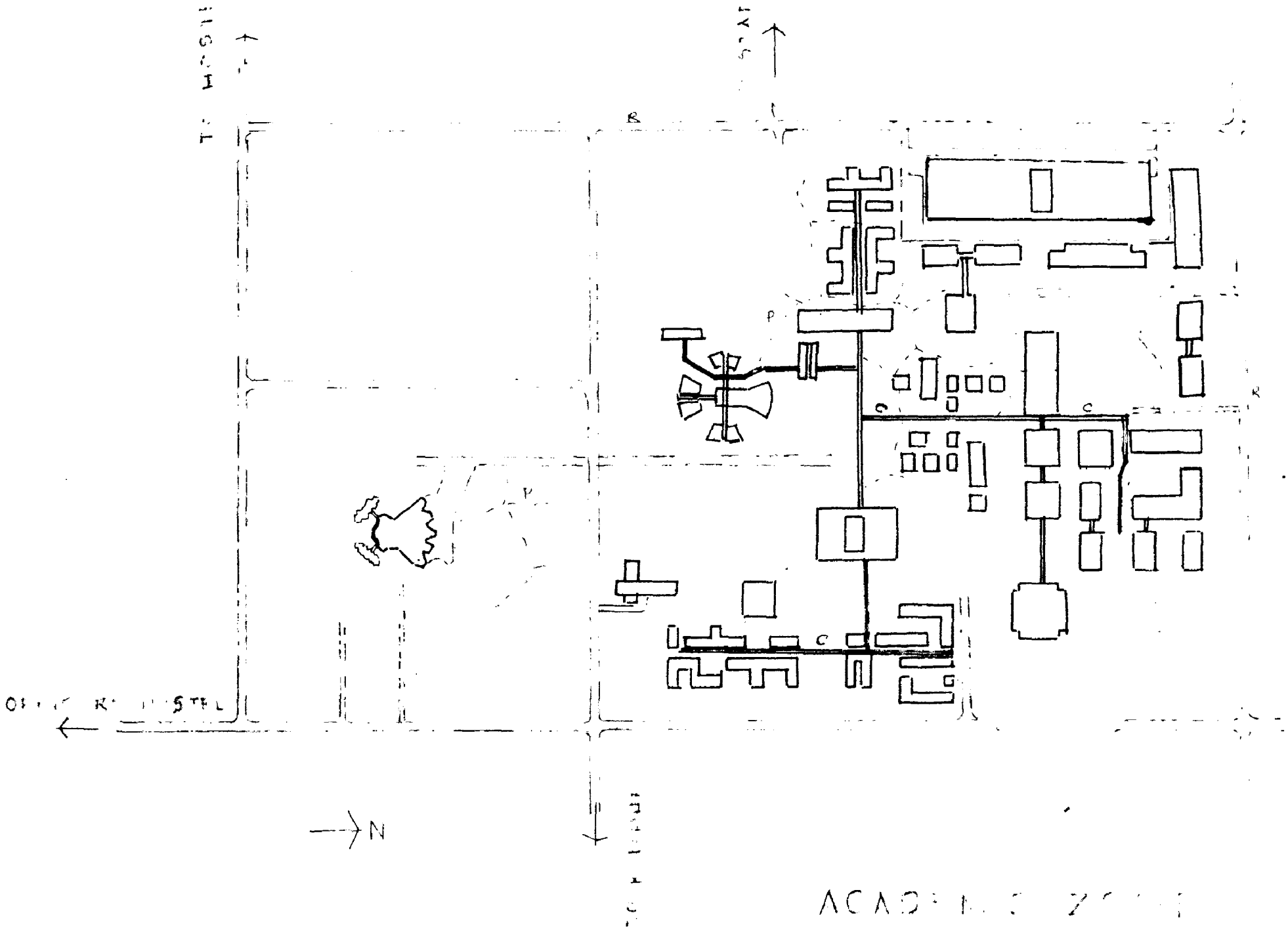
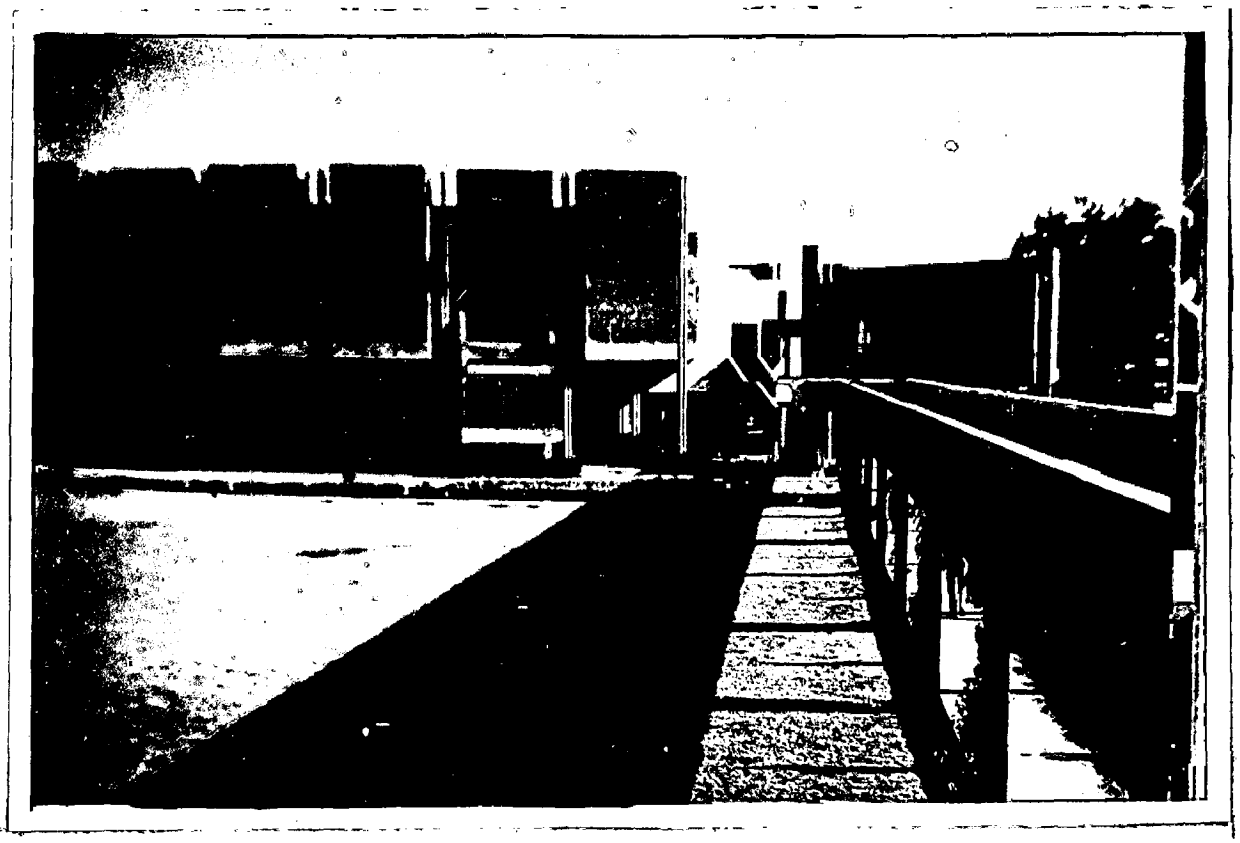

N

PLATE NO 32B



CORRIDORS CONNECTING LECTURE HALLS

AND ACADEMIC BUILDINGS.

FREE PEDESTRIAN MOVEMENTS.

7.2 Indian Institute of Technology, Kanpur

Year of establishment 1961

Site and location: Total site 1040 acres

Developed site 523.4 acres.

The campus is situated about 13 k.m. from Kanpur city on G.T. road towards Delhi.

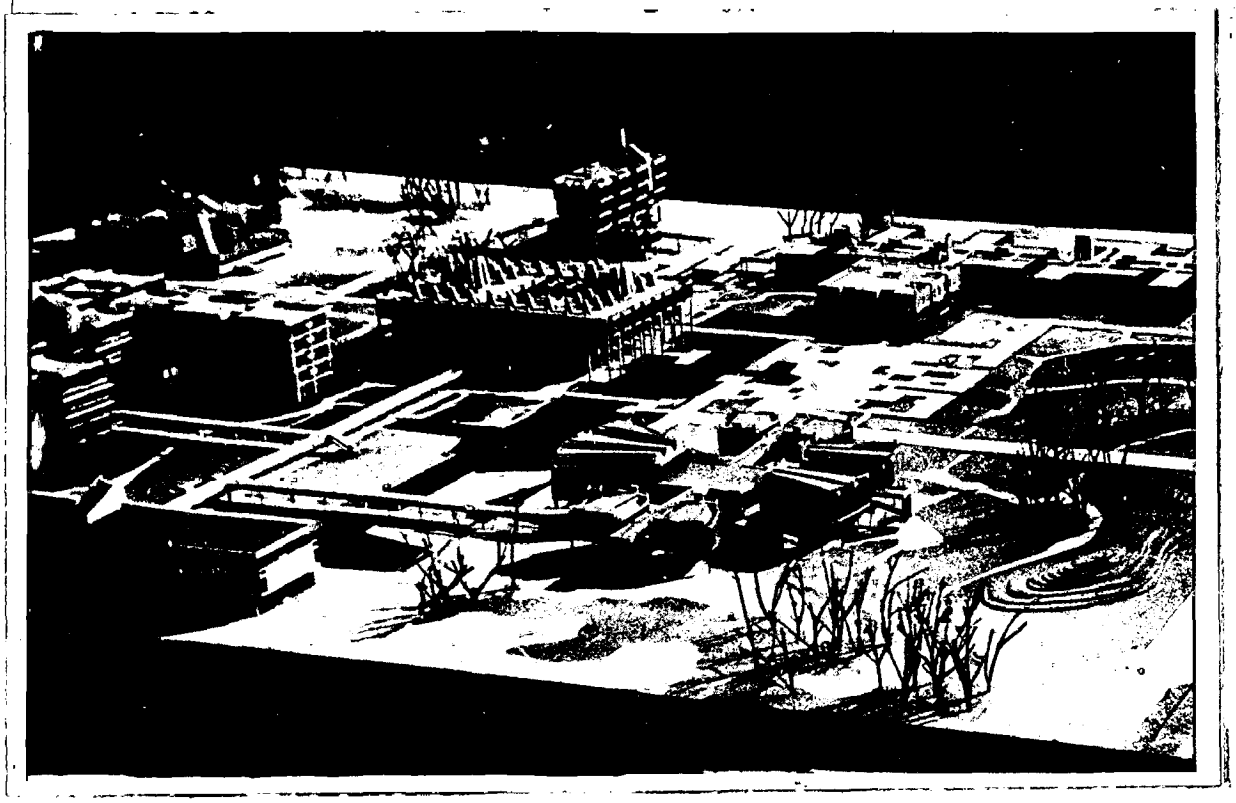
Enrolment number: 2400 students.

Services in Campus:

Campus is planned in sectors and road pattern is grid-iron. Separate pedestrian paths of 2 meter width are provided which generally run parallel to the road. Academic zone is free from vehicular traffic. Buildings in this zone are interconnected with corridors, there are no separate tracks for bicycles (See plate No.32).

Buildings are classified on the basis of their functions and not as per departments. For example all glass rooms are grouped at one place and all laboratories grouped together in one building. So cost of services is reduced. External services are underground. Being a sub-urban campus it has to make provision for two oxidation ponds, seven sump wells, pumping stations and tube-wells for water supply.

PLATE No. 33



I·I·T· KANPUR

ACADEMIC ZONE

Development of Campus:

Developed land is 523.3 acres out of which 20.5 percent is used for academic zone. Here planning is compact and buildings are three storied except main building which is six storied. (See plate No.33).

In residential zone buildings are upto three storeys height and development is horizontal and of the spread out type.

7.3 Punjab University, Chandigarh:

Established in 1956

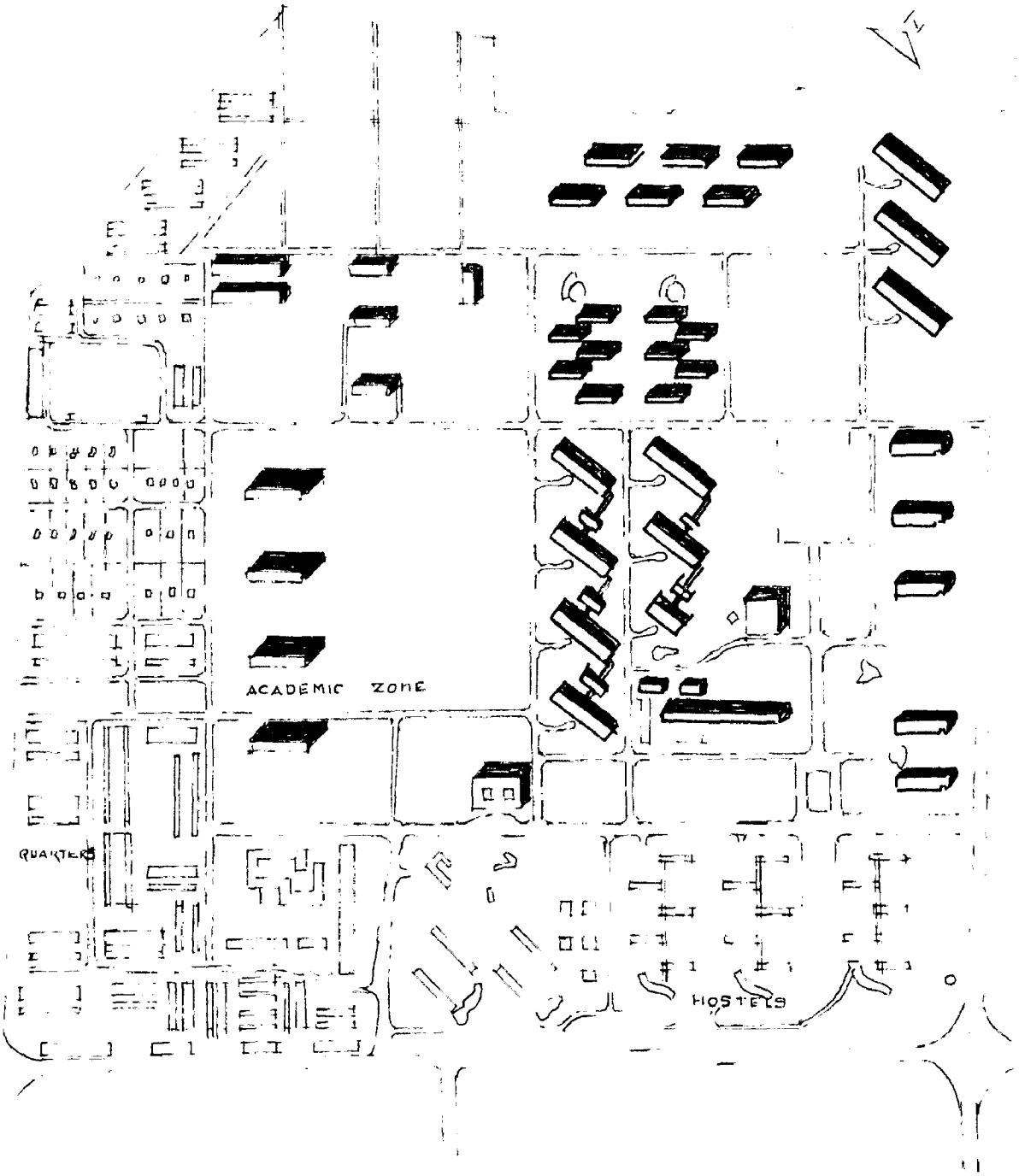
Site and location: Total site 486 acres
Developed site 356 acres and remaining 130 acres for future expansion.

It is located in sector 14, north west of Chandigarh.

Enrolment No. 81657 including affiliated colleges. Twenty seven hundred students are in one campus at Chandigarh.

Services in a Campus:

Campus is planned on sector concept and roads are on grid-iron pattern. Roads are classified in four categories according to traffic viz. Major road 44' wide



PUNJAB UNIVERSITY

CHANDIGARH.

minor roads on campus 22' and other roads 16' and 12' wide. There is a lack of clarity of human and vehicular movement. And academic zone is not separated from vehicular traffic. Vehicular traffic has been given more prominence in this campus. Other services are underground.

Development of Campus:

Administrative building is seven storied whereas other buildings are three storied. Spaces left between academic buildings are too wide which have resulted in horizontal and spread out campus (See plate No.34 and 35). A denser development could have provided coherent intimate spaces and would have used the land efficiently, providing more space for expansion.

7.4 Punjab Agricultural University, Ludhiana:

Established in the year 1962

Site and location: Total site 1203 acres

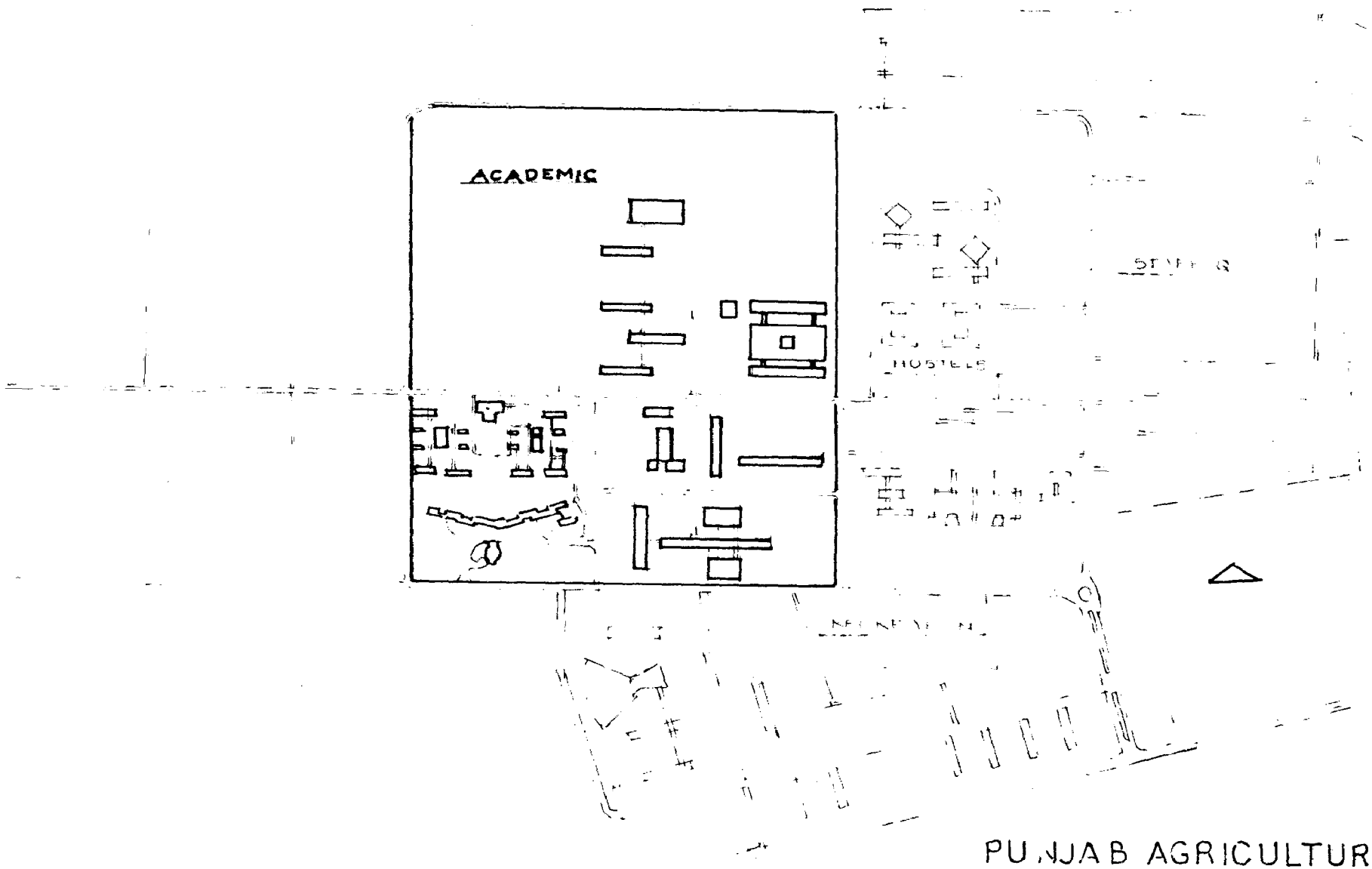
developed site 453 acres

It is located on Ludhiana Firozepur road, 5 K.M. from the city. The campus is yet in the developing stage.

Services in Campus:

The campus is designed with sector concepts and road pattern is grid-iron. Pedestrion paths 2 meter wide

PLATE NO. 36



PUNJAB AGRICULTURAL UNIVERSITY. LUDHIANA

are provided by the side of road with concrete surfacing Proper consideration is not given to make them interesting Side channels are provided for storm water and other services are underground.

Bicycle and vehicle parking is partly sunken in the ground from where departments can be easily approached. This prevents parking infront of buildings to a large extent. Buildings are three storied and spread out. It could have been made into a compact campus. (See plate No.36).

7.5 Cost Analysis:

Cost analysis of the external services in these campuses is done from the data collected in survey. Table No.1 gives land use analysis, Table No.2 gives cost analysis and Table No.3 gives detailed cost analysis of external services.

Concluding Remarks:

From a study of these newly developed residential compuses it is observed that:

a) Although campuses are located in urban or sub-urban areas they have acquired much more land than needed at present, out of which some percentage is kept for future expansion.

b) Developed site used per 100 students varies from 13.2 acres to 21.7 acres. It is least in case of Punjab University, Chandigarh and maximum in case of I.I.T., Kanpur.

c) Overall campus planning is neither compact nor vertical, but spread out and horizontal. This has added to the total cost of the external services. Buildings are 3 to 4 storeys in height except administration buildings which are about six storied.

d) Academic zone is kept free from vehicular traffic except Punjab Univereity, Chandigarh campus. Parking is on the out-skirts of the academic zone and near the buildings. No separate tracks for bicycles are provided.

e) Separate pedestrian paths are provided which are partly covered in some cases. In some cases no consideration is given to its planning and detailing.

f) Cost of roads varies from 2.0 percent to 5.5 percent

of the building costs. It is maximum in case of I.I.T., Kanpur and minimum in case of I.I.T., Delhi. This variation is mainly due to spread out planning and left out open spaces.

g) Cost of sewer lines and storm water drainage varies from 1.1% to 5.5%. It is minimum for Punjab University, Chandigarh and maximum for I.I.T., Kanpur. This increase is because the campus has its own sewage disposal plant since it is away from the city.

h) Similarly variations are observed for other services viz cost of water supply varies from 1.3% to 5.6% and electricity from 0.1% to 7%.

Maximum values are observed in case of I.I.T., Kanpur because it has its own generating sets, pumping sets and tubewells.

i) Thus overall cost of external services varies from 6% to 23% of the building cost. U.G.C. recommends it to be 5% of the building cost for fully developed campuses, 10% for partly developed campuses and 20% for undeveloped campuses.

j) Development costs per acre varies from Rs.7,000/- to Rs.23,000/- and minimum is for Punjab University, Chandigarh.

CHAPTER VIII

CONCLUSION AND RECOMMENDATIONS

8.1 Conclusion:

विद्या विहीनः पशुः ॥

These lines from Sanskrit Literature show the importance of knowledge. Man without knowledge is more like an animal. The urge of higher education is not only observed in present days but from ancient times when poor students rendered services to their Guru's. The Guru or tutor was highly respected in the society. Education was given more importance and a child had to join Gurukula which were located in the natural environment and away from city disturbances. In later period Visvavidyalayas were started for higher learning. Some of them had well planned campuses. Teachers and students used to live in a common way.

But under Muslim and British rule this whole concept was changed-and traditional education got set back. New Institutes were established. In 19th century, campuses were designed

with horizontal and spread out planning without delineation a expansion master plan. The services were non existant.

The number of Universities is increasing mainly because of an urge for higher education. These new University campuses are to be planned economically with consideration for future needs of University. Economy in campus development is a major consideration. Cost analysis of existing campuses done by the author shows that minimum cost of external services for fully developed campus is 6 percent of the building cost. Urbanisation has resulted in shortage of land and increase in land cost. So a campus must be compact with highest and best use of available land.

Use of automobiles has changed circulation system on campus. It has created new problems such as traffic segregation and parking. Campuses designed before a decade had horizontal and spread out planning with large left out spaces. The present trend in campus planning is changed from ground flour to walkup type-generally two or three storied buildings.

On the basis of these studies the author would like to make following recommendations:

8.2 Recommendations:

I. Recommendations for Services:

A) Pedestrian Paths:

1) Pedestrians should have separate paths and foot paths on the side of vehicular road.

2) Academic zone should be free from traffic hazards. Pedestrian paths in this zone should be partly or fully covered.

3) These paths should have shortest and interesting routes.

4) Width of major paths should be 10' and that of minor paths 5'.

B) Vehicular Road:

5) Road pattern should be in accordance with topography. Orientation and solar movements should be considered to avoid glare for both motorists and pedestrians.

6) Road widths will vary with the traffic flow. But in general major road should be 44' wide and minor roads 22' and 16' wide.

7) Vehicle parking should be near the building, probably on the outskirts of the academic zone.

8) Parking if sunken or semi-sunken type it will reduce noise and save land also, in that case terrace can be utilised for other activities.

C) Bicycle traffic:

9) In urban campuses where bicycle traffic is more It is better to provide a separate track or atleast a part of major road should be separated out for bicycle traffic.

10) Parking facilities should be near the buildings.

11) Width of these tracks should be 10' to 12'.

D) Other External Services:

12) These services should preferably, be underground so as to avoid danger and not to spoil building views and trees.

13) While designing these services future growth of campus and increase in demands should be considered on a projected basis.

14) Generally cost of external services decreases with increase in number of storeys and it is minimum for the buildings upto 60' height.

II. Recommendations for Saving in Land:

15) Campus should be a compact one with highest and best use of land. Conservation of land for future uses is essential.

16) The space between two blocks should be atleast 1.4 times the height for direct sun light.

17) Plot area required varies with the size and grouping of buildings. Plot area per storey for any particular grouping decreases with vertical development and is minimum between fourth to six storey. After words there is negligible saving in land.

18) Cost of construction increases with vertical development except for 2nd storey. It increases to a marked degree after 4th storey.

19) So buildings on campuses should be primarily walk-ups i.e. four storey in height.

20) In urban areas where land is costly high rise buildings are recommended. Height will be governed by cost of land, construction and of services.

21) In general, cost of external services for fully developed campus should be 5 percent of buildings costs. 10 percent for partly developed campuses and 20 percent for undeveloped campuses.

APPENDIX I

Speed of Vehicles and Road Capacity for Different Carriage Widths

In Road research laboratory, London research was conducted on road capacity and speed of vehicles. It was observed that maximum efficiency is obtain at 30 miles per hour speed. Assuming uninterrupted flow theoretical capacity is calculated as given under.

Running Speed m.p.h.	Total flow of vehicles/ hour for carriage width of					
	20'	30'	40'	50'	60'	70'
20	-	350	700	1000	1350	1700
15	250	700	1200	1700	2150	2650
10	450	1100	1700	2350	2950	3600

'Man as Driver' Page No.
Paul Ritter

Pergamon Press, Oxford.

APPENDIX XX

Proportion of Plastic Pipes:

Sl. No.	Proportion	P.V.C. Pipes	Low Density Pipes	High Density pipes
1)	Ultimate tensile strength at 25°C	455-600 Kg/m²	115-170 Kg/m²	265-250 Kg/m²
	at 40°C	53 "	91 "	195 "
2)	Recommended temp. range for pressure pipes	-1 to +49°C	-40 to +38°C	-18 to +45°C
3)	Recommended temp. range for non-pressure pipes	-1 to +60°C	-40 to +38°C	-18 to + 18°C
4)	Coefficient of thermal expansion at -5°C	5-6	16-18	11-13
5)	Weather action	Excellent	Good	Good
6)	Abrasion resistance	Good	Moderate	Fair
7)	Flammability	Self extinguishing	Slow	Slow

'Plastics in Building Industry', Page No.

National Building Organisation, April, 1971

APPENDIX III

Increase in Cost of Construction in vertical Development:

Sl.No.	Average cost of construction Rs/Sq.M.	Relative increase
1.	178.03	-
2.	173.99	- 4.09
3.	187.12	+13.12
4.	197.66	+10.54
5.	250.28	+52.62
6.	251.67	+ 1.39
7.	317.67	+66.00
8.	318.60	+ 0.93
9.	321.19	+ 2.59
10.	323.77	+ 2.58
11.	334.85	+11.08
12.	339.80	+ 4.95
13.	342.38	+ 2.58
14.	346.36	+ 3.98

These figures are calculated for dwellings with general specifications and load bearing structure upto four storeys and afterwards frame structure. These figure includes the cost of internal services.

Interrelationship and Impact of Different parameters, page 40 in high density housing' K.L. Datta and B.B. Garg Scientist C.B.R.I., Roorkee

Design incorporating Indian builder, October, 1969.

BIBLIOGRAPHY

1. Dr. Achrya: Manasara, Encyclopaedia of Hindu Architecture Vol.VII, Oxford University Press, Calcutta, (1949).
2. Allen, E.P.: The Street in Evolution, Journal of T.P.I. Feb. (1967).
3. Baswana, A.L.: The Wonder that was India Sidgwick and Jackson, London (1964).
4. Beazly, Elizabeth : Design and detail of the spaces between the buildings, The Architectural Press, London, (1969).
5. Bernestein, Alex. : Campus Planning Part III, Chilled-water Building System Design, July (1971).
6. Bhagi, M.L. : Ancient India: Culture and thought The Indian Publication, Ambala Cantt. (1965).
7. Bor, Walter : High Buildings: A blessing or Curse, Ekistics January, (1965).
8. Blake, Peter: How to grow a campus, The Architectural Forum, April, (1966).
9. Brown, Percy: Indian Architecture, Buddhist Period, Taraporvala and Sons, Bombay, 5th Ed. (1965).
10. Brown, Percy: Indian Architecture, Muslim Period, Taraporvala and Sons, Bombay,
11. Cowan, Henry.J: Historical Outline of Architectural Science, Elsevier Publishing Co., New York, (1966).

12. Calonda, A.L. : Campus Planning Part 4,
Building Systems Design, July (1971).

13. Dent, H.C. : Universities in Transition,
Cohen and West Publication.

14. Dutta, Kumar : Libraries in ancient and Medival India,
Atmaram and Sons, (1970).

15. Durant, Will : The Storey of Civilization,
Our Oriental Heritage, Vol.1
Simon and Schuster, New York, (1954).

16. Dober, R.P. : Campus Planning,
E.F.L. Publication, New York

17. Dober, R.P. : New Campuses in Britain,
E.F.L. Publication, New York

18. Datta, K.K. : Problems of our Universities,
The Education Quarterly, October, 1971.

19. Datta, K.L and Garg, B.B. : Impact of Planning on Cost of Services
Civil Engineering Construction and
Public Works Journal, Dec. (1968).

20. Datta, K.L. and Garg, B.B. : Inter-relationship and impact of
different parameters in high density
housing,
Design Incorporating Indian Builder
Cot., (1969).

21. Flook, Walter J : Campus Planning Part 5
Building System Design, July, (1971).

22. Gokhale, B.G. : Ancient India, History and Culture
Asia Publication House, Bombay, (1959).

23. Gauman, S. : Campus Planning, The Construction Phase
Building System Design, July, (1971).

24. Husain, Yusuf. : Glimpse of Madival Indian Culture,
Asia Publishing House, (1962).

25. Kanvinde, A. and Miller : Campus Planning in India,
Sponsored by U.S. Agency for
International Development.

26. Lappo, Osmo. : A University, A town in a Town,
Indian Architecture, July, (1970).

27. Marshall, John. : A Guide to Taxila,
Govt. Printing Press, Calcutta, (1918).

28. Mehta, R.N. : Pre Buddhist India
Examiner Press, Bombay, (1959).

29. Nielson, L.S. : Standard Plumbing Engineering Design,
MacGraw Hill Book Co.,

30. Newman, Oscar. : New Campuses
The Architectural Forum, May, (1966).

31. Puri, B.N. : Cities of Ancient India,
Minakshi Prakashan, (1966).

32. Poovar, U.V. : Physical Development of an Urban
University in the Context of Social
needs, Ekistics Oct. (1971).

33. Palladino, N.J. and Waidhas B.R. :Education in Multi Campus University American Society of Engineering Education, Dec. (1969).

34. Rubenstein, H.M. :A Guide to Site and Environment Planning John Wiley and Sons, Inc. New York, (1969).

35. Rico, A.M. :Modern University, Tavistock Publication, (1970).

36. Rehards, J.M. :Designing of New Universities Indian Architect, Feb. (1972).

37. Rittor, Paul. :Planning for Man and Motor, Pergamon Press, London, (196).

38. Ricci, A.A. :Campus Planning the Approach, Part I Building System Design, July, (1971).

39. Son, G.E. :The Story of Early Indian Civilisation Oriental Longmans, Bombay, (1964).

40. Shrivastava, P.R. :Study of Historic Town of Nalanda, Thesis Report School of Planning, Delhi (1966).

41. Sahani . :Road Engineering Sugrantha Technical Publication, Railway Road, Roorkee.

42. Shah, M.C. :University Campus Planning:Concepts and Standards, Thesis, School of Planning, New Delhi, (1964).

43. Uppal, S.L. : Electrical Wiring, Estimating and Costing,
Khanna Publication.

44. University Hand Book : India and Ceylone
Inter University Board of India and Ceylone Publication, (1968).

45. Weinstock, R. : Space and Dollars
An Urban University Expands

46. Wekerle, Gerda. : High Rise Living
Ekistics March, (1972).

47. —— Architectural Review Oct. (1963).
A Special Issue on Universities.

48. Schmertz, P.M. Campus Architecture
Architectural Record, Feb. (1970).

49. —— University Planning Report of Discussio
Special Issue, Progressive Architecture
Sept. (1960).

50. Editorial University in the Town,
Architectural Review, July, (1964).

51. Editorial University Planning who was Right,
Planning for Growth and Change,
Architectural Record, Nov. (1967).

52. Bantom, William. Encyclopaedia Britanica, Vol.4 and 21
Published by Bantom William. (Editor)

53. Brawne, M. University Planning and Design
A Symposium at Sussex University, (196).
Edited by M. Brawne.