Studio learning through an inclusive approach

TEACHING WORKSHOP

Faculty of Architecture CEPT University Ahmedabad

October 13 2012

R J Vasavada

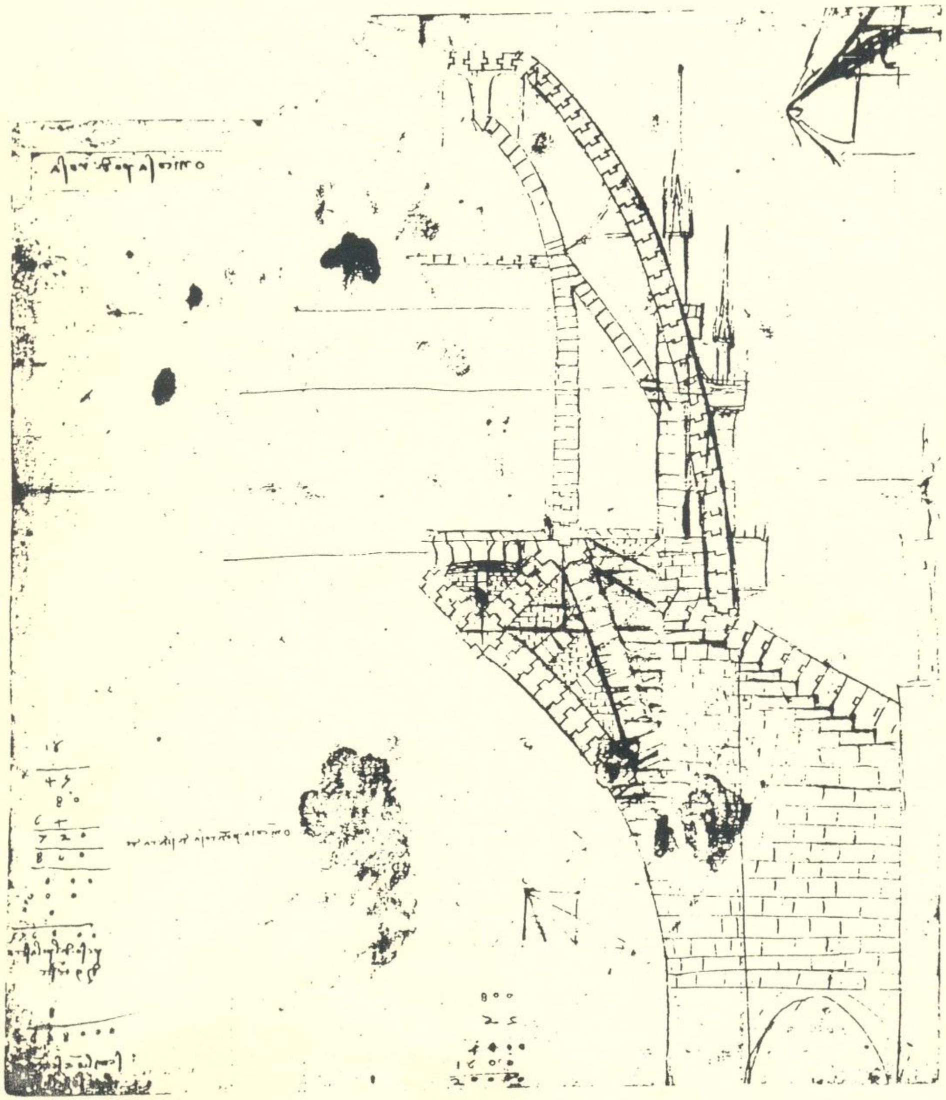
Developing approaches in Studio instructions by introducing exercises which aims at integrating technology (engineering) and workshop (skills) in studio. The studio orients to the aspects of inspirational sources (Nature) as a basis to imagining design and its realization through a process of understanding its making (structure and Form) in a contextual format (purpose).

- From the inception of the School of Architecture, there are four mainstream modules within the course. These are Studio (which is the culmination of all), Technology, Humanities and Arts and Crafts. All these streams are expected to culminate into a holistic learning experience for the students which reflect in their Studio work.

Studio III

89-90

R. J. Vasavada



School of Architecture Ahmedabad.

Introduction :

Studio III at the School of Architecture deals with the understanding of basic aspects of architecture. The studio provides a bridge in a way from basic design (first year) to basic architecture. It begins by the study of two distinct areas of structure: the physical and perceptual. Physical refers to how a structure (as far as we can humanly determine), actually is from micro (atom) to macro (universe) levels. In this we are concerned with variables; invariables, deformations and transformations. Perceptual refers to normal behavioural patterns of our sensory receptors, i.e., our everyday touching of the world and the meanings we construct out of these encounters, analogous to physical situatio[ns] those things that possess identities (or grouping properties) and those that create contrasts, are the basic concerns of the percept[ual] phenomena.

In contrast to basic design, architecture demands a thorough understanding of man, his behavioural patterns and his institution[s] besides the thorough understanding of natural objects and phenomen[a]. These we observe, normally in two ways; by a rigourous scruti[ny] employed in scientific investigations; and through a superficial, even detatched, experiencing of environment, which we take as a reality of our mundane existence. It is also one of the most remarkable of properties of the human to have at his own disposal the capacity to arrange, to rearrange, to structure; not against the impossible but against the improbable. If one of the man's natural faculties is to arrange the improbables; this faculty is devoid of meaning, if, it cannot fulfil his purpose or need. But to this end, man is endowed with a second greatinterdependent talent: the ability to predict that course or those courses of action that are most likely to bring him to his desired goal. His ability to arrange gives him the power to control, or at least influence his condition. So it is here that he reaches over into architecture, graphics, and industrial design, as well as painting and sculpture, and out of the pure realm of basic studies.

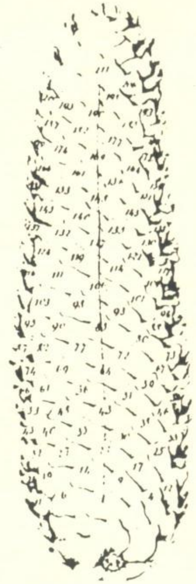
While the function of basic design can be said to be pedagogic and of value in decision-making processes, the function of basic architecture exposes the realms of phenomena of nature and understanding of man and society.

One of the designer's prime concern is a responsibility for the aesthetic culture (in which he ultimately takes a moral position). The designer is the co-ordinator, the integrator, the unifier of the environment - where he works more in terms of relationships or arrangements than of objects or elements.

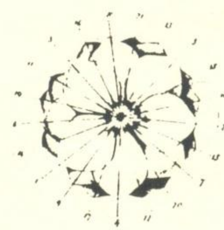
John Dewey writes: In order to be aesthetic, structure has to be more than physical and mathematical.

Structure strictly mean: the relationship or arrangement of parts or elements: to design, then, is first of all to structure: and the study of structure (in the abstract) is the equal of that which has been known as basic design or foundation studies.

THE STRUCTURAL ANALOGUES:

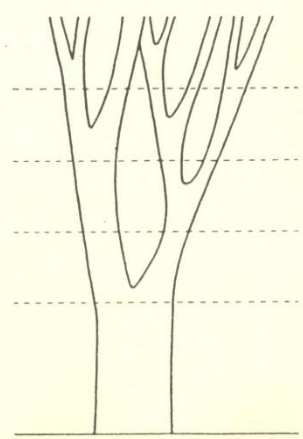


'Cells and tissues, shell and bone leaf and flower, are so many portions of matter, and it is in obedience to the laws of physics that their particles have been moved, moulded and conformed. They are no exception to the rule that God always geometrizes. Their problems of growth are essentially physical problems, and the morphologist is, ipso facto, a student of physical science' (Thompson, d'Arcy: Growth & Form, vol. 1 p. 10)



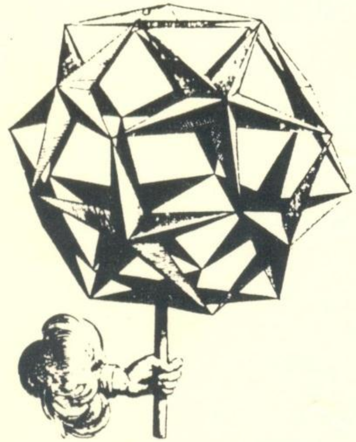
Right: Fir cone in plan and elevation showing families of left-handed and right-handed spirals, revealing a 5:8 combination of the Fibonacci Series.

- 'A mathematical coincidence devoid of biological significance' (Thompson)

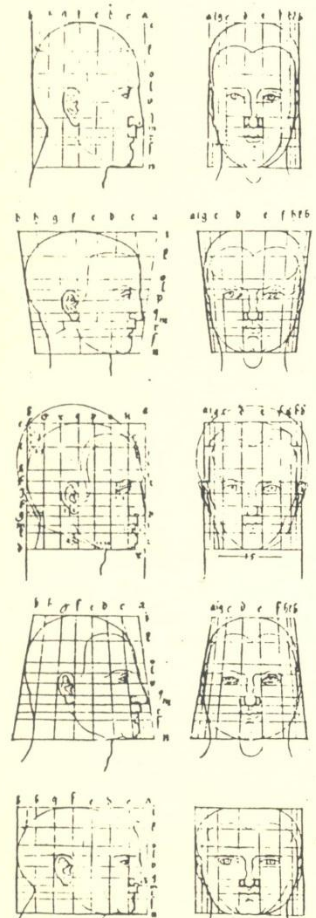


Right: 'If a tree puts forth a new branch after one year, and always rests for an year, and if the same law applies to each branch, then in the first year we should have only the trunk, in the second, two branches, in the third, three, and then five, eight, thirteen, etc., as in Fibonacci sequence -

Left: Pentagonal dodecahedral pyrite crystals conform to the cubic system and thus display faces that are not completely regular Platonic dodecahedrons due to their inter-atomic natures.



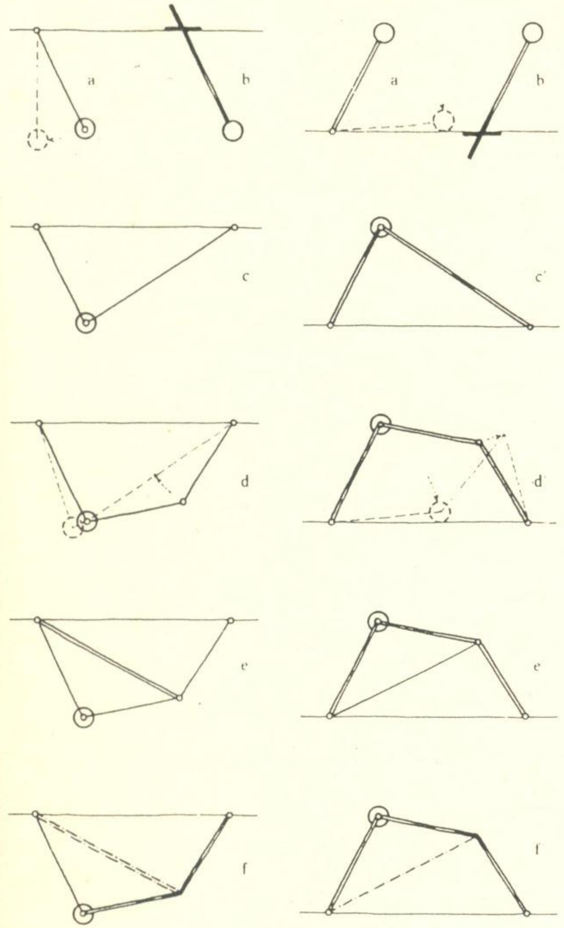
A stellar polyhedron, which could well be a Pythagorean cosmic-diagram with the hand of creation holding an icoso-dodecahedron constellated by twelve five-pointed stars, having the golden section locked into their proportions.



Transformation of the male physiognomy by A. Dürer.

Below: Drawings by leonardo-da-vinci of human shoulder.

THE LEARNING:

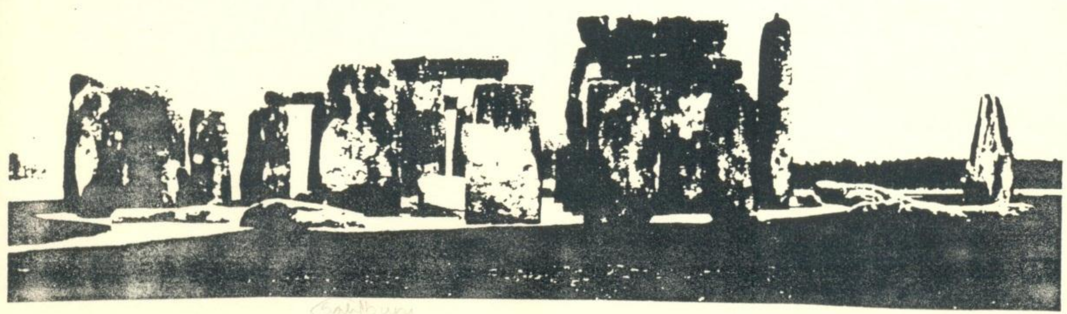


Geometric aspects of static equilibrium

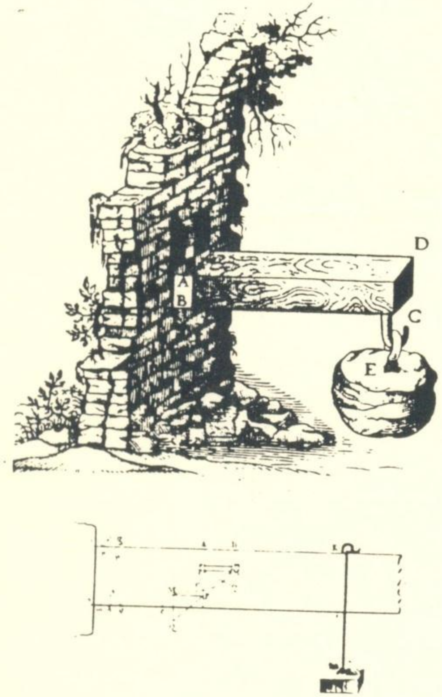
The figures show some of the simplest possible ways of supporting a weight (shown by a large circle) by one, two, three or four structural elements either above a fixed base or below a fixed overhead support.

In the sketches single or double full lines represent the individual elements: small open circles represent pinned joints allowing free rotation: and solid black represents rigid joints allowing no rotation. All joints can resist either tension or compression.

Merely from a consideration of the possibilities of movement, it is clear that configuration a, a' and d, d' would be unstable in the sense that they would be incapable of maintaining the weight in its initial position. All the other configuration would be just stable without any surplus sources of stiffness, if we ignore for the moment the elements shown by chain-dotted lines in f, f'. From the equivalance of b and c, b' and c', e and f, e' and f', it can be seen that the manner of jointing can be as important as the number and configuration of the elements.



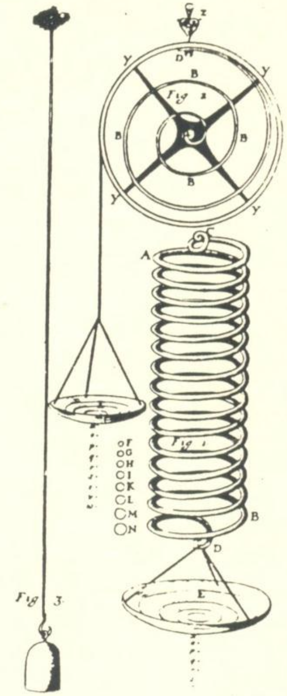
stone henge, near Salisbury.



TOP - studies of the behaviour of a cantilever beam by Galileo and (bottom) by Coulomb

Galileo observed that rotation would occur around the bottom edge. at B.

Coulomb more correctly assumed that the internal stresses over the depth of the cross section would vary continuously from compression at the bottom to tension at the top, and that in addition to these stresses acting longitudinally, there would be vertical shear stresses.



TOP. Studies of Elasticity by Hooke.

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4. Developments in Structural form. R.J. Mainstone, 1975.

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Academic Frame-work:

Architecture is a field, not a plant. It is a broad subject, not a narrow one. It cannot be organized without creating a broad band of related interests, some professional - some academic. In teaching it, there is no way of avoiding a complex organizational problem. There is a crucial difficulty in teaching the synthesis of a complex and many factored subject; there are no conclusive models from the tradition.

The formats developed in earlier times, it was possible for the strong minded men (Gaudet, etc.) to enunciate a list of elements of architecture alongwith rules for an architectural composition. The elements were evolved in order that they should be built to-gether into compositions, where as the many factors now held to be important in the design of the built-environment arise empirically from other subjects and have not been evolved with a view to composition.

The integration demanded of our students is at an operational level, not an emotional level. And the learning must have a personal impact on the student. We are faced to-day into a situation where teaching and learning are faced over into an opposition. Teaching becomes identified with subject definition: only a well defined subject can be 'taught.' Learing becomes identified with individual experience: only a personally relevant subject can be 'learnt'. The double role of science, with its alternation of conviction and correction, is thus polarized and split into incompatible worlds. The opposition of learning and teaching arises from a defensive posture on the part of a teacher or learner. Failure of teaching or learning is felt primarily by the learner. The responsibility, however, of organizing a successful learning situation must rest with the teacher.

Therefore, it is important to develop a dialectical framework for teaching and learning, in which the two modes of action are made to alternate and interact, just as in science, conviction is always followed by correction in cyclic operation. But this dialectic is still not the satisfactory solution for architectural education as between the Building Sciences (which has sound empirical basis) and the designing (which concerns with form, prestige etc) is the subject of the interaction of form and function (individual design-ideas) which is normally difficult to appreciate as we only apply our judgement and not the full understanding of the subject. For the satisfactory balance, therefore, teaching must be able to provide comparable assessment and criticism and an assurance for the same.

The frame-work suggested for Studio III this semester, therefore, comprises of three main streams, which are inter-related, yet delivered separately, in a parallel studio learning-teaching-interactive-situations.

1 EL	1+2 = 3 DE	2 PI
EXPERIENTIAL LEARNING (REALITY)	STUDIO EXERCISES (INTERACTION)	PEDAGOGIC ILLUSTRATIONS (THEORY)
Based on work on selected example of built-form to understand the architecture.	Based on defined parameters with increasing complexity in a stage-wise sequence.	Based on theoritical inputs on Building Science, Nature and man in general. Lecture / Illustrations

The Contents : *

EL (3-stages)		**DE** (3-stages)		**PI** (6 aspects)
Basic studies & (object of learning)		Design Exercise & (object of exercises)		Theoritical Instructions & (details of knowledge)
Experiencing (balance, symmetry, feel)	1	Perception / Grasp (visual balance & symmetry)	1	Architecture - discipline 29.07.80
				Learning from Nature
Analysis (components, relationship)	2	Space / Order of Plan (function & organization)	2	Man-made forms.
				Material & Technology
Lessons. (structural resolutions,) (purposefulness, logic)	3	Structure / Form (Inter relationship & image)	3	Science & Engineering
				Role of Designer.

The schedule :

EL	**DE**	**PI**
Phase (discussions)	Phase (Reviews)	Sessions (Lectures)
1 - JUL 14, 28	1 - JUL, 28 **	1 - JUL 10 •
		2 - JUL 24 •
2 - AUG 11, 25	2 - AUG 31 **	3 - AUG 07
		4 - AUG 28
3 - SEP 08, 22	3 - SEP 29 **	5 - SEP 05
		6 - SEP 18

** denotes stage evaluation for individual presentations.

* The details of tasks involved in **EL** and also of exercises under **DE** are being issued separately.

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2	3.1/1598/2374	Steinmann, DB & Watson SR	Bridges and their Builders
3	3.3/1112	Angerer F	Surface Structures in Building
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4	3.3/5092	Otto F and Trostel R	Tensile Structures: Cable Nets & Pneumatics
5	3.3/5093	Otto F and Schleyer FK	Tensile Structures: Cable Nets and Pneumatics
✓6	3.3/5152	Salvadori M & Heller R	✓Structure in Architecture
✓7	3.5/518	Devey N A	✓A History of Building Materials
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29	4.52/322	Lawerence A W	Greek Architecture
30	4.52/217	Pevsner N	An Outline of European Architecture
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33	7.1/3959	Rapoport A	House form and Culture

Studio III
July 14,88

LEARNING FROM NATURE-1

Lecture - *1*
R.J.Vasavada.

- -

Topics for the lecture :

Natural phenomenon as the basis for human knowledge in science and art.

Five natural elements as the prime source of life.

Life exists as a result of balance of nature.

Living organisms draw support from nature by appropriating natural elements synthesising life supporting materials.

Living organism also appropriate their immediate surroundings for their physical existence. cell - tissues, shell - bones, leaf - flower

Context · Living organisms are specific to varying natural conditions.

Specificity of natural conditions generate homogeneous living organisms.

Life cycle in nature is an account of forces and reactions in a constant search for balance for existence.

Protection Life cycle is regenerative in order to sustain life. The process of regeneration anticipates protective measures as life has varying degrees of endurance which is conditioned by age (time).

Strength for endurance and protection from severity of nature become the reasons to develop a shield to safeguard life.

Forms of life Life in nature takes various forms.

Each form of life reflects the phenomena of nature through its inherent structuring as also its evolution.

ecology Forms of life in nature including human beings display the commonness of evolution and so they are analogous. So also are their methods to exist in nature.

- -

Assignments for self d iscovery;

- Study any one form of life in nature that interests you.
- Try and reflect on the above points as far as the selected study is concerned.
- Identify the inherent mechanism which sustains the life (body).
- Try to graphically represent the idea through proportionate sketches.
- continue your inquiry once you begin as what you might have already known would be just a drop in the vastness of what is unknown !

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Studies III
Lecture 1

PLATE 32.

Forms of Crystallization; Various Instruments

Figure

1. Blowpipe
2. Attenuated point of flame caused by the blowpipe
3. Forceps
4. Berzelius blowpipe
5. Nicholson areometer
6. Magnetic needle
7, *ab*. Instrument for detecting electricity in minerals
8. Common goniometer
9. Gambay's goniometer
10. Wollaston's goniometer

Forms of Crystallization

11, 12. Regular octahedron
13. Octahedron abbreviated to a six sided plate
14. Cube
15. Relation of the cube and octahedron
16, 17. Cubic octahedron
18. Rhombic dodecahedron
19. Relation of the rhombic dodecahedron and cube
20. Pyramidal cube
21, 24. Cube with dodecahedral faces replacing its edges
22. Octahedron with dodecahedral faces
23. Octahedron passing into a dodecahedron
24. See 21
25. Combination of cube faces and those of the pyramidal cube
26. Tetrahedron

tetrahedron

28. Cube with its edges replaced by three faces
29. Pentagonal dodecahedron
30. Trapezohedron
31. Octahedron passing into a trapezohedron
32. Obtuse square octahedron
33. Acute square octahedron
34. Square octahedron with two corners truncated
35. Right square prism
36. Regular eight sided prism
37. Right square prism with its corners truncated
38. Square octahedron with truncated basal edges
39. Square octahedron with truncated lateral edges
40. Eight sided pyramid
41. Twelve sided prism
42. Six sided prism with bevelled edges
43. Right square prism with basal edges truncated
44. Rectangular octahedron
45. Rectangular octahedron truncated
46. Square octahedron with bevelled lateral edges
47, *a*. Obtuse rhombic octahedron
b. Acute rhombic octahedron
c. Rectangular octahedron
48. Rhombic octahedron with two corners bevelled
49. Octahedron with the corners of the vertical axis replaced by four plane faces
50. Right rhombic prism
51. Right rhombic prism with obtuse edges truncated
52. Irregular eight sided prism
53–55. Combination of prisms belonging to the trimetric system
56. Rectangular prism
57, 58. Modified octahedrons
59, 60. Oblique six sided prism
61. Octahedron with half the edges truncated
62. Prism with half the basal edges truncated
63–65. Oblique rhomboidal prism

67. Double six sided pyramid
68. Pyramidal six sided prism
69. Modified rhombic octahedron
70. Regular six sided prism
71. Regular six sided prism with truncated basal edges
72. Regular six sided prism with truncated corners
73. Obtuse double six sided pyramid
74. Scalene octahedron
75. Rhombohedron
76. Six sided prism with four edges bevelled
77, 78. Natural situation of two rhombohedrons
79. Grouping of crystallizations
80–87, 90, 91. Forms of ground jewels
88, 89. Crystalline formations
90, 91. See 80, etc.
92, 93. Crystalline structure

PLATE 34.

Minerals and Their Crystalline Forms

Figure

1. Micaceous iron ore
2, 3. Quartz
4. Tourmaline
5. Hematite
6. Datholite
7. Pyrolusite
8. Tin ore
9. Fibrous brown hematite
10. Rutile
11. Scaly hematite
12. Andalusite
13. Asbestos
14. Stilbite
15. Analcime
16. Mesotype
17. Apophyllite
18. Chabazite
19. Tin ore in granite
20. Reniform hematite
21, 22. Silica
23, 25. Oxyde of iron
24. Manganite
25. See 23
26. Braunite
27. Red copper ore
28. Apophyllite
29. Hausmannite
30. Sapphire
31. Oxyde of iron
32. Anatase
33. Red copper ore
34. Tourmaline
35. Augite
36. Quartz
37. Oxyde of tin
38. Corundum
39, 40. Arsenious acid
41. Picrosmine
42. Oxyde of tin
43. Rutile
44. Oxyde of copper
45. Nepheline
46. Scapolite
47. Staurotide
48, 53. Idocrase
49. Beryl
50. Thomsonite
51. Silica
52. Augite
53. See 48
54. Chondrotite
55. Humboldtite
56. Various silicates
57. Emerald
58. Euclase
59. Natrolite
60. Dichroite
61. Oxyde of copper
62. Prehnite
63. Epistilbite
64. Garnet
65. Albite
66. Chabazite
67. Pyroxene
68, 69. Beryl
70. Staurotide
71. Iolite
72. Silica
73. Datholite
74. Olivine
75. Hornblende
76. Feldspar

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R. J. Vasavada (22-7-88)
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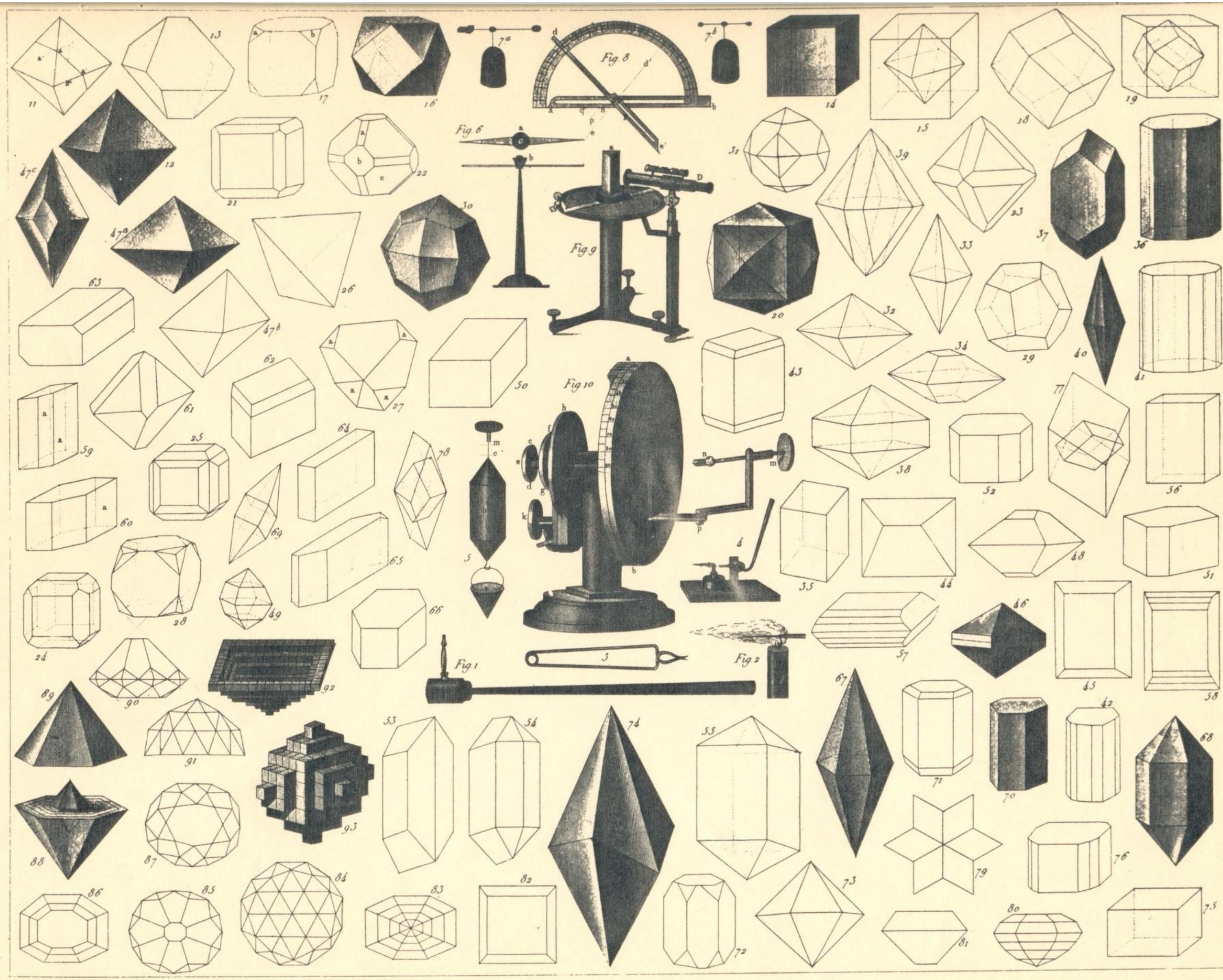
of Illustrations of Urban



G. Heck dir.t Henry Winkles sc.

PLATE 32. FORMS OF CRYSTALLIZATION; VARIOUS INSTRUMENTS

G. Heck dir.t

Henry Winkles sculp.t

PLATE 34. MINERALS AND THEIR CRYSTALLINE FORMS

RJV

STUDIO III — LEARNING FROM NATURE - 2 — Lecture -*2*
July 22,88 — R.J.Vasavada

Topica for the Lecture :

Stability in Nature as the basis for human Knowledge in construction.

Observation of natural forms for its structure to withstand forces of nature as the prime source of inspiration for man to build.

Natural and Man made forms exist as a result of balance of force and reactions these have to withstand retaining their position in gravity.

Natural and man made forms are in a state of static equilibrium.

Natural and Man made forms have definite structure,which is a system with its own sense of Geometry.

The structure is dependant on the system and its contact(base)with earth.

Natural structure are organic in nature (each part is a complete system) whereas man made structures are assembly of parts which may or may not be complete system by themselves.

Natural and manmade forms are material specific. Material properties dictate the nature of forms.

The way natural/formation govern natural forms,construction technics govern manmade forms. Technic and form, Formation and form.

Na tural forms are three dimensionally formed entities,while man made forms are resolved primarily to two dimensional resolutions - mainly answering gravity.

There are many types of natural forms and formations,living and otherwise, similarly there are many variations to man made forms,depending on the context of time and place,from rock-cut to modular.

The forms that we would concentrate both natural and man made are those used to appropriate an environment within.

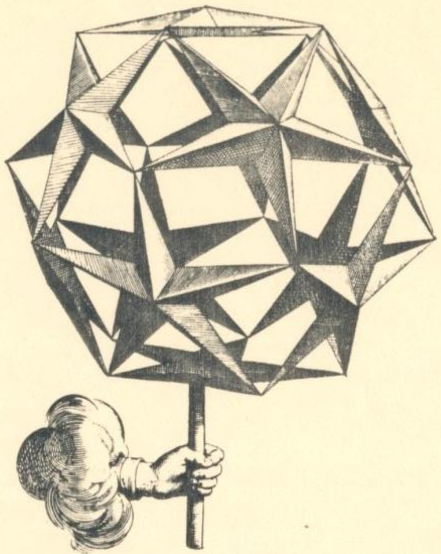
The scale and function are the points to be clearly understood while one establishes a parallel between man made and natural forms.

Man made forms exhibit a process of construction while the matural forms are a result of natural growth. In the natural process the control is by internal and external stimuli. Construction process is controlled by the conscious will. Construction proceeds by successive additions and approx imations.At any inbeetween stage the form is incomplete.Not so in the natural forms, every stage display completeness.

The aspect of choice is governing the man made forms and also the scale the structural function and also the need to piece by piece putting to-gethe r.

Assignment for self exploration and understanding:

- Study one natural form for its structure,geometry and relevance.
- Study one analogus man made form for its structure,geometry and purpose
- Document both the above by your preferred medium expressively.



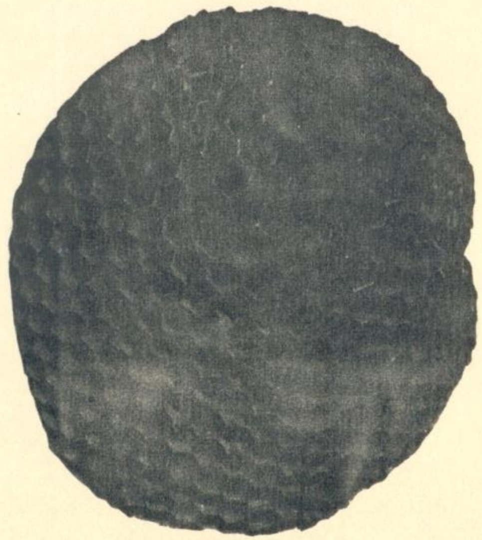
'Cell and tissue, shell and bone, leaf and flower, are so many portions of matter, and it is in obedience to the laws of physics that their particles have been moved, moulded and conformed. They are no exception to the rule that God always geometrizes. Their problems of growth are essentially physical problems, and the morphologist is, *ipso facto,* a student of physical science.'[1]
At the same time, Thompson, with uncompromising scholarship and unfaltering insight, weaves a counter-

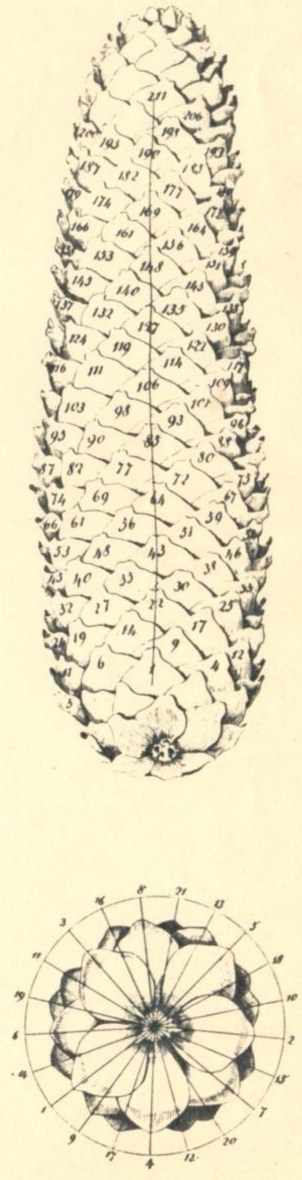
Left A *stellar polyhedron*, which could well be a Pythagorean cosmic-diagram with the hand of creation holding an icoso-dodecahedron constellated by twelve five-pointed stars, having the golden section locked into their proportions

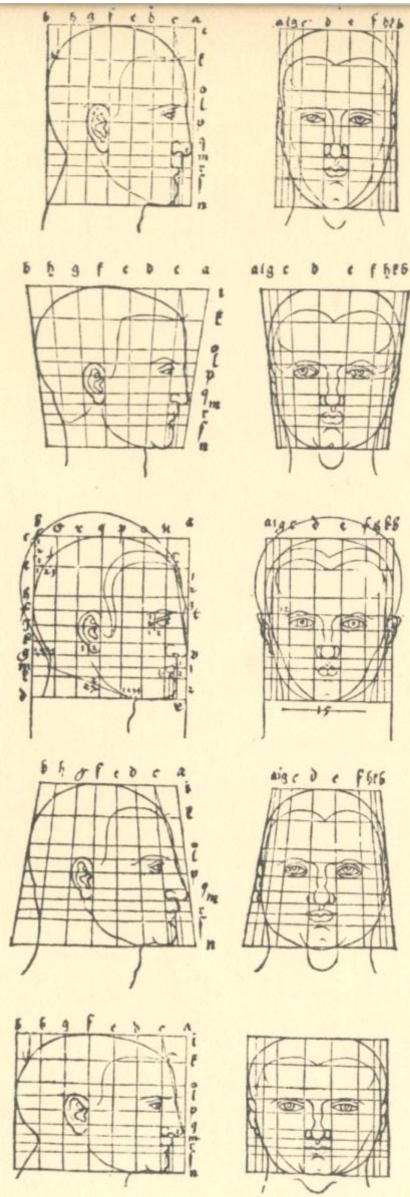
Below, left Sir D'Arcy Wentworth Thompson

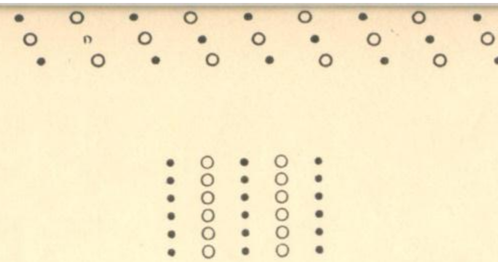
Below A comb of the paper wasp

Right Fir cone in plan and elevation showing families of left-handed and right-handed spirals, revealing a 5 : 8 combination of the Fibonacci series







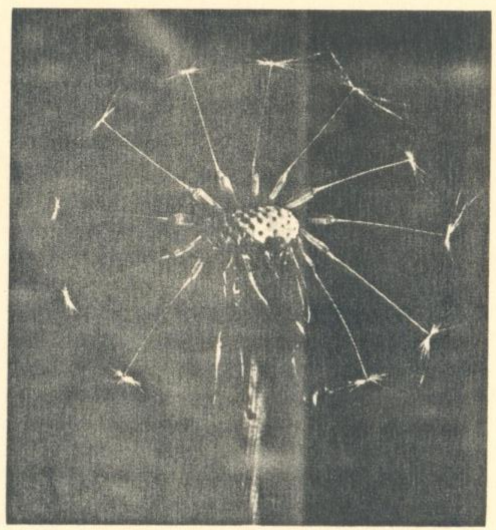


Ulm's Maldonado), my students and I explore, of the physical nature of structure, such groups as can be analysed by symmetry, topology, combinatorial analysis, theories of colour and texture.
Much is to be learned about structure from an examination of both inorganic (static) and organic (dynamic) morphology. A famous passage from D'Arcy Thompson indicates what insight might thereby be derived:

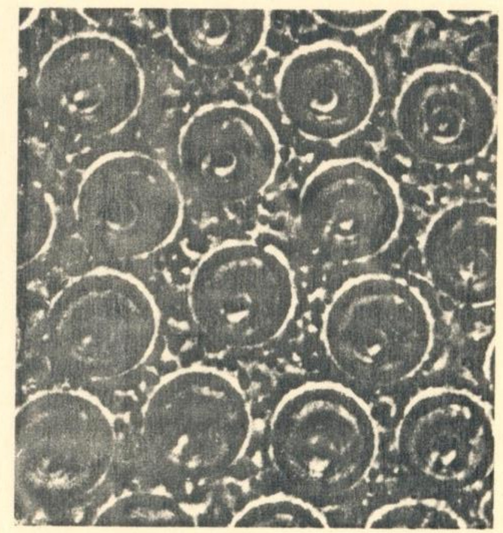
Above, left The factors of similarity and proximity, functioning towards the same end of vertical emphasis, are strengthened in example (a) and, through opposition with one another, weakened in example (b)

Centre, left Pentagonal dodecahedral pyrite crystals conform to the cubic system and thus display faces that are not completely regular. In fact, no crystals can form regular Platonic dodecahedrons due to their integer-atomic natures

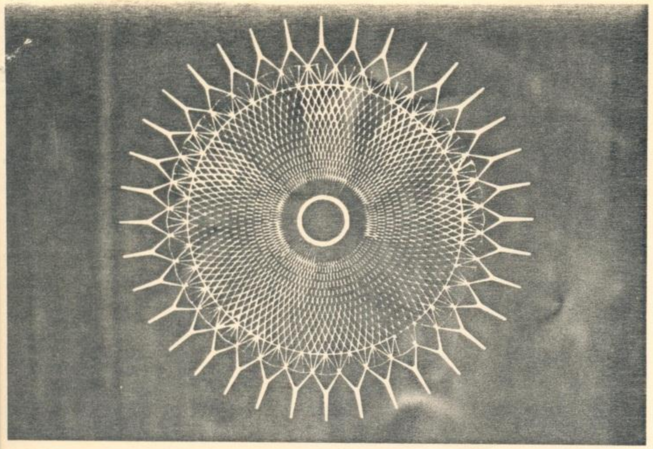
Far left Transformations of the male physiognomy by Dürer

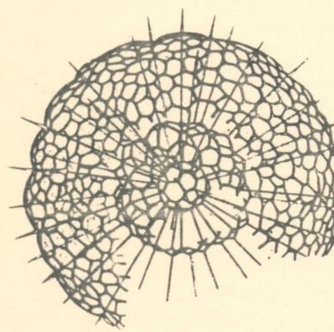


Dandelion clock



Eye lenses of a firefly

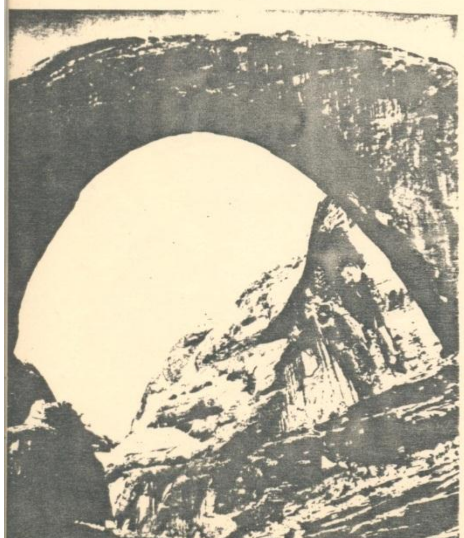




1.2 (*above*) Plan of the dome and its supporting struts. Small Sports Palace, Rome (Nervi).

1.3 Skeleton of the radiolarian *Actinomma arcadophorum*.

1.4 Genesis of the design for the third Eddystone Lighthouse.



4.2 (*right*) Rainbow Arch natural bridge, Utah.

STUDIO III | BUILDING MATERIALS & CONSTRUCTION | Lecture *3*
July 28,88 | Basic Materials. | R.J.Vasavada

Topics for the lecture :

TIMBER as one of the earliest building materials.

' It is the only one which is the direct product of natural growth, and which is subject as it grows to structural actions comparable with those to which it is afterwards subjected in its use by man'. Although there is a difference between its state - a tree is living and when cut, dead. This brings in significant changes in its inner structure.

As part of tree, structural efficiency is very high -axial compression, bending which were met by c losely packed system of fibres running in the direction of stress. When cut timber can still withstand the axial compression and tension, but are weak in resisting stresses such as compression across the grains or shearing along the grain.

Strength of timber depends on the grains. Transmission of compression in timber is easier, tension is very difficult at joints.

Two basic classification of timber depending upon their natural growth; 1.Hardwoods, withvery close system of fibres, and softwoods belonging to the c oniferous variety of trees. Over the centuries the quantum of hardwoods have considerably depleted and the softwoods have replaced them in building

Emergence of new technologies have brought in various processes for manufa cturing products from timber through lamination and compression.

Construction technics based on perfection of joints to transmit stresses. With advent of synthetic glues much better results are possible.

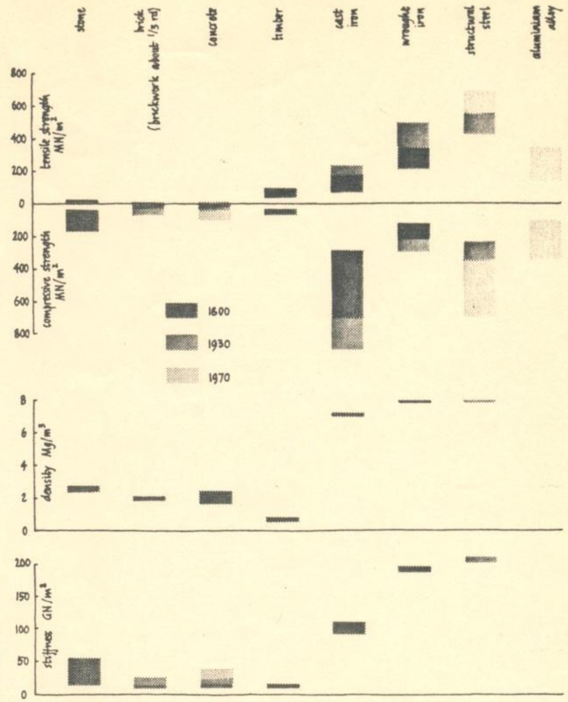
Timber is very effectively used in combination with other materials like stone, brick, mud, preca st blocks etc., or alone with infills.

Pos ts, beams, brackets, floors, roof-trusses etc. are the building components in practice. In pres ent times compos ite structures are also possible using engineered products.

Timber building, being one of the most ancient form, has inspired many a later developments in building in other materials universally. Reflections of timber forms of constru c tion can be observed in our rock-cut architec ture and stone construction. Unfor tunately the records are not available as the material has always been very vulnerable to fire and destruction.

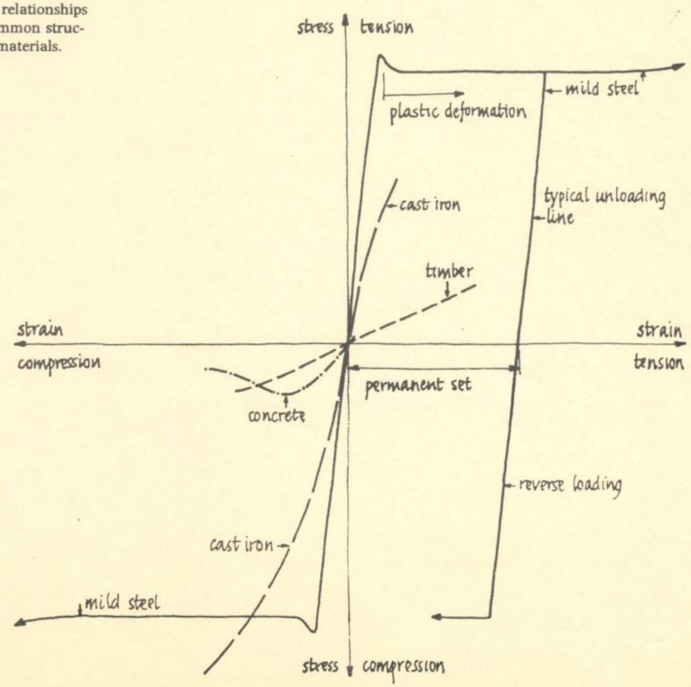
Assignment :

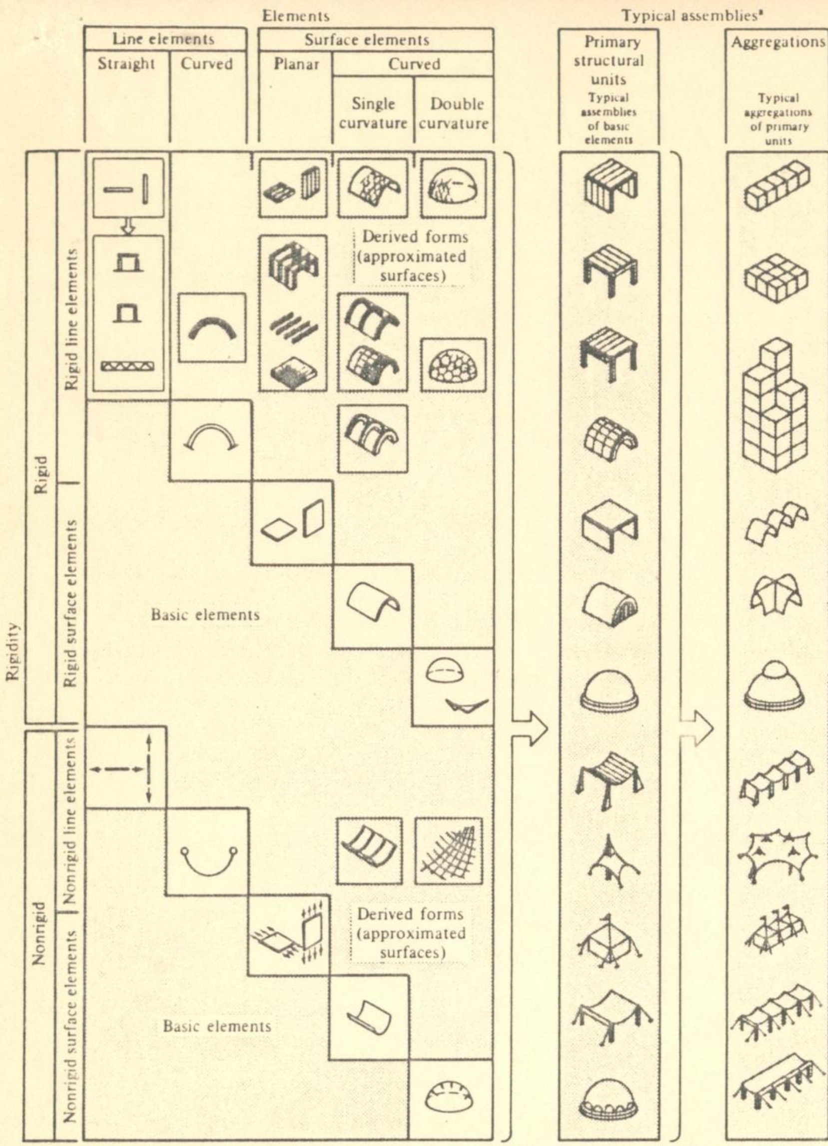
1. Visit the Timber Market and observe various specimen of Teak wood.
2. Obtain two pieces of approximately 45cms length, 7.5cms.sq.section with uniform grains.
3. Choose any one specific joint from the illustrations attached here and using our workshop, construct the same joint carefully aligning grains.
4. Through graphic diagrams show the role of this joint in an overall structural assembly showing the stress directions.



3.2 Approximate ranges of strengths, density, and stiffness for materials available up to 1850, up to 1930, and up to 1970.

3.1 Typical stress–strain relationships for common structural materials.





[a]These assemblies and aggregations are samplings only, since the permutations actually possible are large.

FIGURE 1-2 Classification of basic structural elements according to geometry and primary physical characteristics. Typical primary structural units and other aggregations are also illustrated.

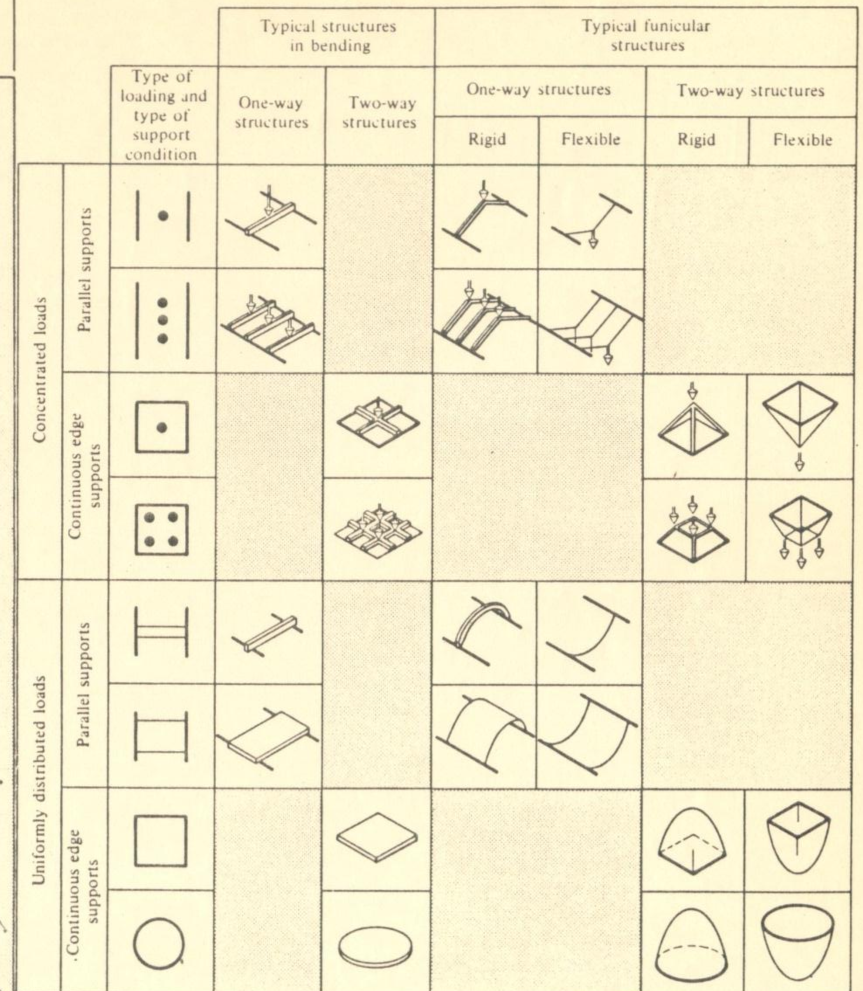
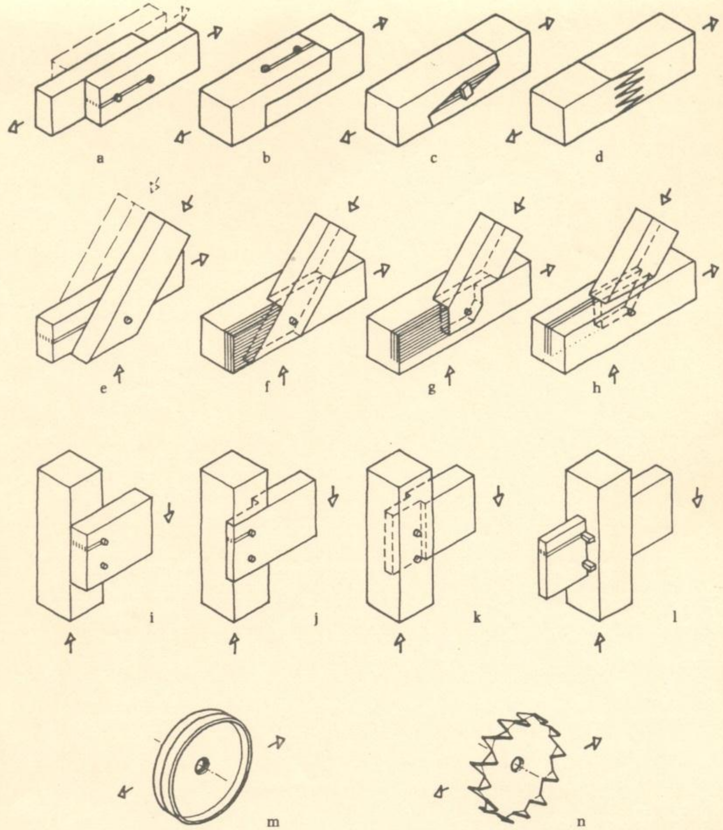
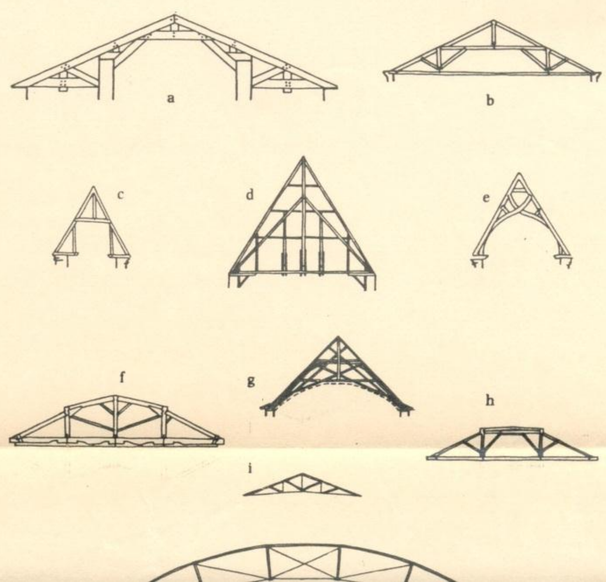


FIGURE 1-18 Classification of typical structures according to their basic load-carrying actions.



3.11 Typical joints in timber (see text).



9.2 Roof trusses of the second to nineteenth centuries: [a] Pantheon portico, Rome, 2nd century; [b] Teatro Olympico, Vicenza, 16th century; [c, e] 13th century after Villard de Honnecourt; [d] nave of Notre Dame, Paris, 13th century; [f] Sheldonian Theatre, Oxford, 17th century; [g] church at Steinach, 18th century; [h] Royal Hospital, Greenwich, 18th century; [i] Euston Station, London, 1837; [j] Lime Street Station, Liverpool, 1849.

STUDIO III
AUG. 5, '88

BUILDING MATERIALS AND CONSTRUCTION - 2
STONE

LECTURE - 4
R. J. VASAVADA

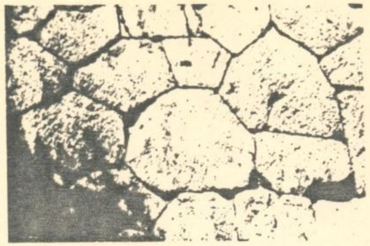
ASSIGNMENT : - OBSERVE ANY ONE STONE STRUCTURE OF CHOICE
- CAREFULLY IDENTIFY UNIT OR STONE, ITS SHAPE, SIZE AND GRAINS IN SUPPORT AND SPANNING
- DOCUMENT YOUR STUDIES THROUGH SCALED DRAWINGS

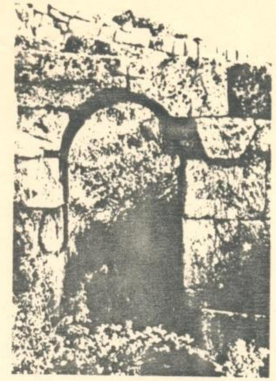
TOPICS FOR DISCUSSION :

- Stone amongst the oldest of building materials.
- Strength characteristics varying based on geological formations.
- Mainly classified as follows :

① PRIMARY OR IGNEOUS	② SEDIMENTORY OR SECONDARY	③ METAMORPHIC
↓	↓	↓
VOLCANIC ACTION AND SOLIDIFICATION OF MOLTEN MAGMA	DEPOSITION OF FRAGMENTS OF PRIMARY ONES.	DERIVED FROM PRIMARY OR SECONDARY BY HEAT PRESSURE OR CHEMICAL ACTION
↓	↓	↓
GRANITE	SAND AND LIME STONES	MARBLE FROM LIME STONE SIGNIFICANT.
↓	↓	↓
NO NATURAL BEDS OR CLEAVAGE PLANES	DIPOSITED IN BEDS UNDER LAND OR WATER, SPLIT.	LAYERED DEPOSITS
↓	↓	↓
CRYSTALLINE, VERY HARD DIFFICULT TO WORK WITH	SOFT, PORUS, SAND STONES ARE HARDER, EASY TO WORK DRESS, SAW	BRITTLE, VERY STRONG CRYSTELLINE, EASY TO WORK.
↓	↓	↓
IN SITU CONSTRUCTION METHODS, MASONRY TO FACILITATE SIZE AND IRREGULAR COURSING	REGULAR MASONRY, PRE DRESSING & SIZING DONE SURFACES OF CONTACT ARE SMOOTHE FINISHED.	REGULAR MASONRY, PRE DRESSING, SIZING CLAMPING, DOVETAILING TENONNING.
↓	↓	↓
SIMPLEST STRUCTURAL FORM DUE TO DIFFICULTY IN HANDLING.	VARIOUS STRUCTURAL FORMS BECAUSE OF SMALLER UNITS	REFINEMENT, ORNATE STRUCTURAL TREATMENT

- Very strong in compression, weak in tension, lateral forces & shear along cleavage planes. Joints ideally should be at right angles to compression.
- Choice of form limited to those where all actions result in compression by fitting the blocks together to distribute stresses as uniformly as possible.
- Where direction of loading vary, voussiors, dowels, tenons are employed.
- Vaults, Domes possible using well dressed long pieces of stone exploiting its tensile strength to maximum.

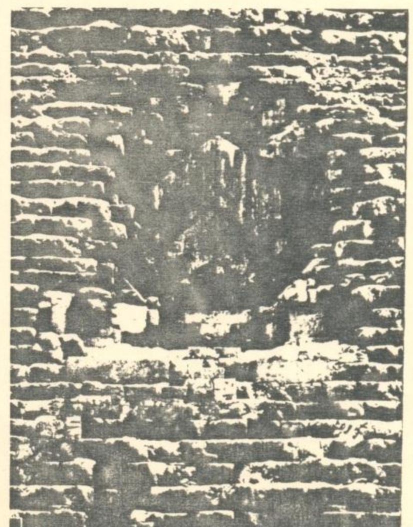




6.7 (*right*)
'Pseudo arch' in
the polygonal masonry
of the defence wall.
Segni.

6.3 (*above right*)
Small gateway in
the northern defence
walls. Selinunte.

6.4 Hut near Gordes.
Provence.



6.1 (*left*) Bridge
between Tiryns and
Epidaurus.

6.2 (*above*)
North entrance.
Pyramid of Cheops.
Giza.

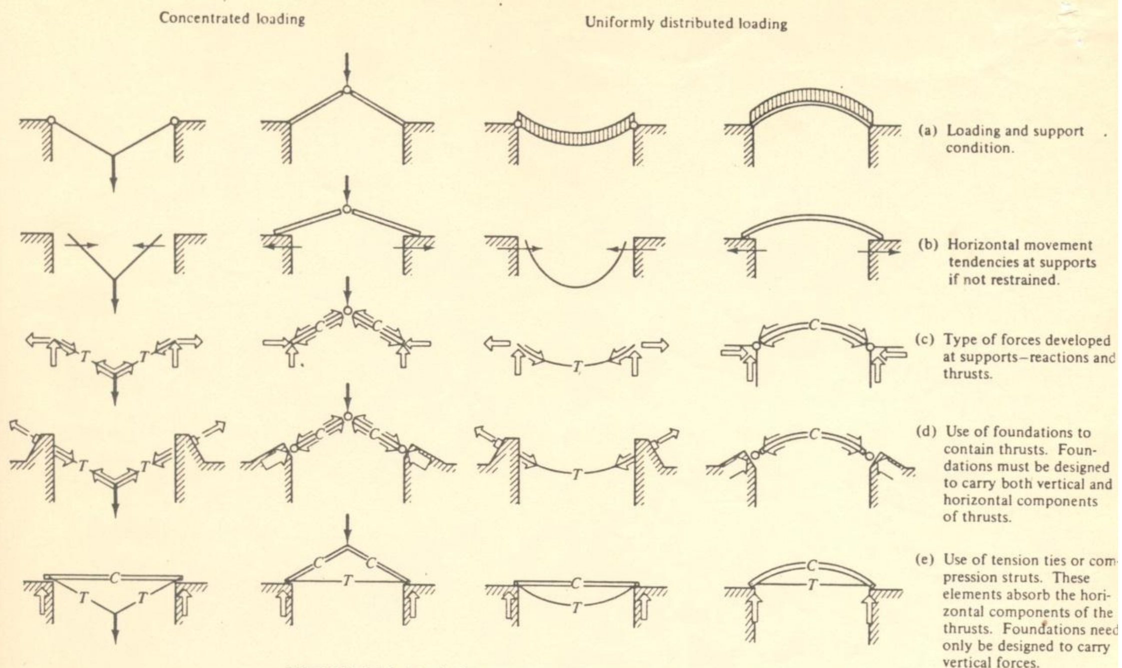


FIGURE 1-17 Funicular structures. Transformations derived from basic shapes.

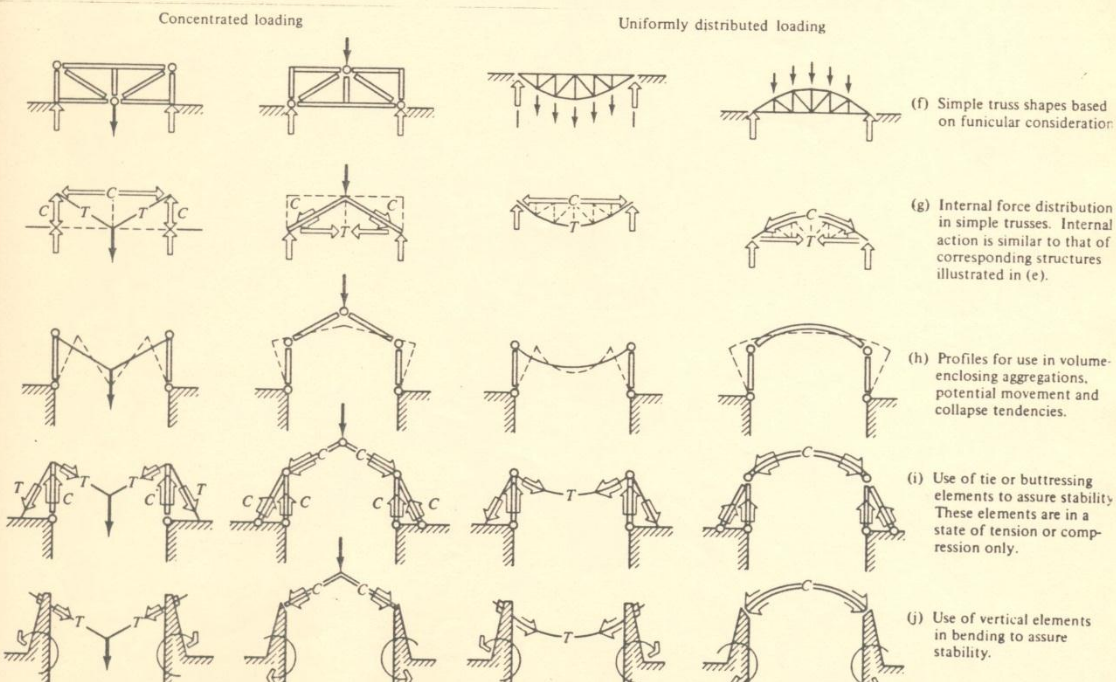


FIGURE 1-17 (cont.)

Brick as one of the oldest building materials :

Topics for discussion :

- One of the simplest and easily available building material for the construction of simple dwellings to monuments,especially in the alluvial regions.

- Alluvial soil,straw and reeds formed the basic materials for making sun dried building blocks or rammed mud walls.

- Rammed,consolidated mud dried in sun with a protective layer to face rains is quite capable of resisting modest compressive loading.

- When used in mass quantities,drying is slow and straw tends to give rise to cracking. Therefore,to form units out of small lumps and allow them to dry before using them in walls is more convinient.

- Sun dried mud bricks of high quality have been in use in construction from ancient times,set in mud mortar often with reed mats in horizon tal joints for construction of massive walls of considerable height.

- The chief drawback of sun dried mud bricks was poor durability in alternate wetting and drying. This was overcome by firing the bricks at a temperature abo ve 1 000°C.to obtain the burnt bricks as we know.

- Bricks became a major building material in almost all civilizations and has been used for all types of buildings during various phases of architectural history.

- When compared to stone,bricks differ in three ways; their compressive strength vary individually,they are essentially small units,and the process of manufacture makes it impossible to achieve a trueness of surface and accuracy of shape and size sufficient to permit their use without relatively wide mortar joints.

- Compressive strength of brick work is comparatively less than that of stone and its tensile strength is negligable.

- Being a smaller unit in size it is very convinient in construction of arches and vaults,the curvature is easily taken by slight tapering of joints. For such forms,it has an advantage over stone.

- Other forms of fired clay products used in building are similar in character to bricks,like roof tiles,hollow blocks,ceramic fuse etc.

- Taking into consideration your study of various civilizations in History course,compile information on use of bricks in building in various building examples of different cultures.

- Prepare explanatory sketches to illustrate the use of bricks in various types of buildind forms.

Reinforced Cement Concrete:

Topics for discussion :

- Reinforced Concrete Construction seen as a form of Composite Constru ction,made possible by the invention of Portland Cement in around 1850s

- Portland Cement(clinker+slurry of crushed chalk or limestones and clay) mild steel cages,water,sand and gravel as the basic materials.

- Mild steel bars plain and with indented surface used which develops bo nd due to shrinkage of concrete on setting. Shrinkage is also to controlled by shrinkage reinforcement which prevents cracking.

- Shrinkage and hardening helps the tight gripping of bars and because of more or less same expansion/contraction of both the materials in heat and cold,the sections act as one.

- Steel resist the tension and has to be placed in the regions where it is required to do so,while concrete resists compression. By varying the proportion of these a wide range of strength and stiffness can be achi eved in a fixed cross sectional dimension of a member.

- Neither steel or concrete alone can have sufficient strength to begin with,it is necessary to devise formwork to cast the members in its form for which substantial formwork is necessary.This form work has to stay fit without deflection until the poured RCC has hardened.

- Formwork also limits the possibility of shapes and sizes for economical and practical reasons. It can be built with timber and steel,and has to be reusable.

- Two approaches are possible to formwork.One is to prepare the formwork on site and cast the concrete in situ,or second,individual components of structure could be cast in a yard and assembled on site.

- Constructional connections vary depending upon the above two technics. In case of insitu construction,the joints in successive pouring is ensured by longer reinforcements and natural bond is created by the shrinkage. The joints w ill not be monolith but will create the same strength.If the components are precast,the joining is done almost as in timber or steel. Joints are finally secured by same slurry.

- Prestressed Concrete : Because of cracking of concrete,and subsequent means to solve that problem without unduly loosing the sdvantages of steel or concrete,prestreesing is done to overcome this problem.

- Prestressing by tensioning the steel or by exerting external force on concrete.Both operations introduce undersize or oversize elements.

- Pretensioning or post tensioning of steel,Loss of strength in tension in pretensioning,advantages of posttensioning,better quality steel.

- Precasting and pretensioning, cast in situ and posttensioning.

Stages of construction & laying out :

Topics of importance :

- Stages of construction deliniate the process of realization of a building project.
- Construction details meet with the requirements demanded by the stages of construction.
- Stages of construction demand practical solutions towards articulating the construction sequence to factors associated with physical context of building.
- Stages of construction also catagorize the tasks of building in time with various trades of building.
- Practical demands of constructions process have necessiated the development of various laying out processes.
- FORMWORK for composite construction especially in RCC is an important area of laying out of construction which governs the out come of constructional details.
- FORMWORK is also necessary in moulding building components and also in masonry construction to facilitate construction processes of building components.
- FORMWORK is also necessary to layout various stages of construction
- Shoring - strutting - shuttering - centering - formwork are terms known to explain various stages of laying out.
- In RCC - formwork has to be DESIGNED to deliniate sequences of construction. Foundations, superstructure, floor structure etc.
- Use of Timber and steel form work is practical considering the nature of form. At times permanent formwork, which stays in position, is practical considering the effort and expenses of the otherwise strikable form work.
- Form work leaves marks on surfaces in RCC construction. Designers sensitive to honest representation of construction take advantage of this to achieve Textural beauty to buildings facade out of such practical implications.
- Form work reflects True strength character of real buildings as they support the buildings in progress.

Iron and Steel :

Topics for discussion :

- Use of metal in building construction to strengthen the masonry was known since Roman and even earlier.

- Use of iron and steel as structural materials in their own right has been relatively recent, primarily as these metals have been available from their natural forms only after the industrial processes have been developed.

- Iron ore available from nature is heated with reducing agent (carbon - coke) to remove oxygen. Reducing agent also serves as fuel to produce necessary temperature. If temperature is not adequate soft iron (blacksmith's iron) is produced. (Which was used in antiquity and Middle ages) With higher temperature (after 15th century) iron could be run off to moulds which is known as Pig-iron. This can be re-melt and moulded and is known as Cast-Iron. Pigs can be further purified to remove carbon and forged as it is softer and is known as wrought-iron.

- Steel is also produced by purifying Pigs, but it retains a bit more carbon than wrought-iron and is less soft. It can be rolled at red heat in various shapes, and also can be formed when cold. Its strengths can be modified by adding other metals. These are known as Alloys. (high tensile, high yield, stainless and weathering steel)

- Cast Iron became easily available in 18th century, until then softer iron was used in secondary roles. (cramps, tie bars etc.) later 18th and first half of 19th century saw wide spread use of cast Iron, although because of unknown effects of casting, the role largely restricted to compressive forms. (replacing timber)

- Wrought iron and Steel replaced cast-iron then on, because of their improved performance in tension, ductility and freedom from hidden defects, also the production processes which offered standardized sections.

- Steel replaced wrought-iron by end of 19th century because of the ease in production, although, taking away the freedom of choice of forms for casting which was available in irons.

- Members in steel were constant in cross section and assemby only was possible from these available sections.

- Under overloading cast-iron breaks suddenly where as steel deforms shedding the load to another part of structure. on removal of excessive load it reverts to its limits known as permanent set.

- Connections with rivetting and bolting requiring brackets, cleats, gussets and cover plates between different members. Rivets are inserted red-hot so that on cooling they draw members tightly to-gether. Ideally the load is transferred by friction at meeting faces: in case of failure it is carried by shear within the rivets. Bolts function similarly except that the tension could be controlled and transmittal through friction is ensured.

- Welding is a fusion process and is capable of directly connecting two members, and transmitting tension, compression or shear as though members were one. welding and bolting in combination also provide full structural contenmity. Its chief drawback is the process which is by heating causing distortion in members if precautions are not taken; it also calls for a careful fusion.

- Ductility of wrought-iron and steel allows for cold rolling of wires from 1cm bars and these are used in purely tensile situations. Cold rolling does not permit recrystallization, athough this develops an entirely new material which has been produced from wrought iron and steel (early and late 19th century). Only drawback of this material is its weak resistence to fire. which is weaker than wrought iron or steel. Paint and surface coating provides additional security against this.

Assignment:

Document through measured sketches any one 'joint' connection of a steel structure of your preference, which has impressed you for its permanence and grace.

STUDIO III
SEPT 9 '88

REGIONAL ARCHITECTURE :
Indegeneous materials/methods/forms.

LECTURE - 9
R.J. VASAVADA.

Topics for discussion :

- Regional architecture as a "straight forward response to both human needs and environmental forces."
- Sharing of local resources to achieve "highly economical and practical form of unselfconscious architecture rooted in time less principles of reason rather than temporary fashion or whim".
- " Alongwith many benefits, advanced technology has allowed us to be impractical, with the knowledge that artificial means are available to overcome inefficiency." (Ref: J.S. Taylor : Commonsense Architecture)

- Environment of a region as the strongest determinant of Form.
  Form counters - negative environmental conditions
  Form is constructed out of locally available materials
  The above two factors are responsible for the dinstinctive regional character of pre-industrial indegeneous architecture.

- Accomodation of human needs into built-form is the second determinant of the form.
  Form provides for the purposive intentions
  Form is appropriated befitting the life-style of people in a region.
  The above two factors are responsible for the timeless quality of indegeneous architecture of any time as it touches the universality of human needs.

- "When one has completed the necessary ..... one immediately comes upon the beautiful and pleasing." - Voltaire :

Assignment :

From your memory and observations recollect the impression of a building you have seen which in your opinion helps you appreciate the above points : share your views by bringing along sketches highlighting the above points.

Studio III
Sept 16, '88

Regional Architecture
Environmental factors.

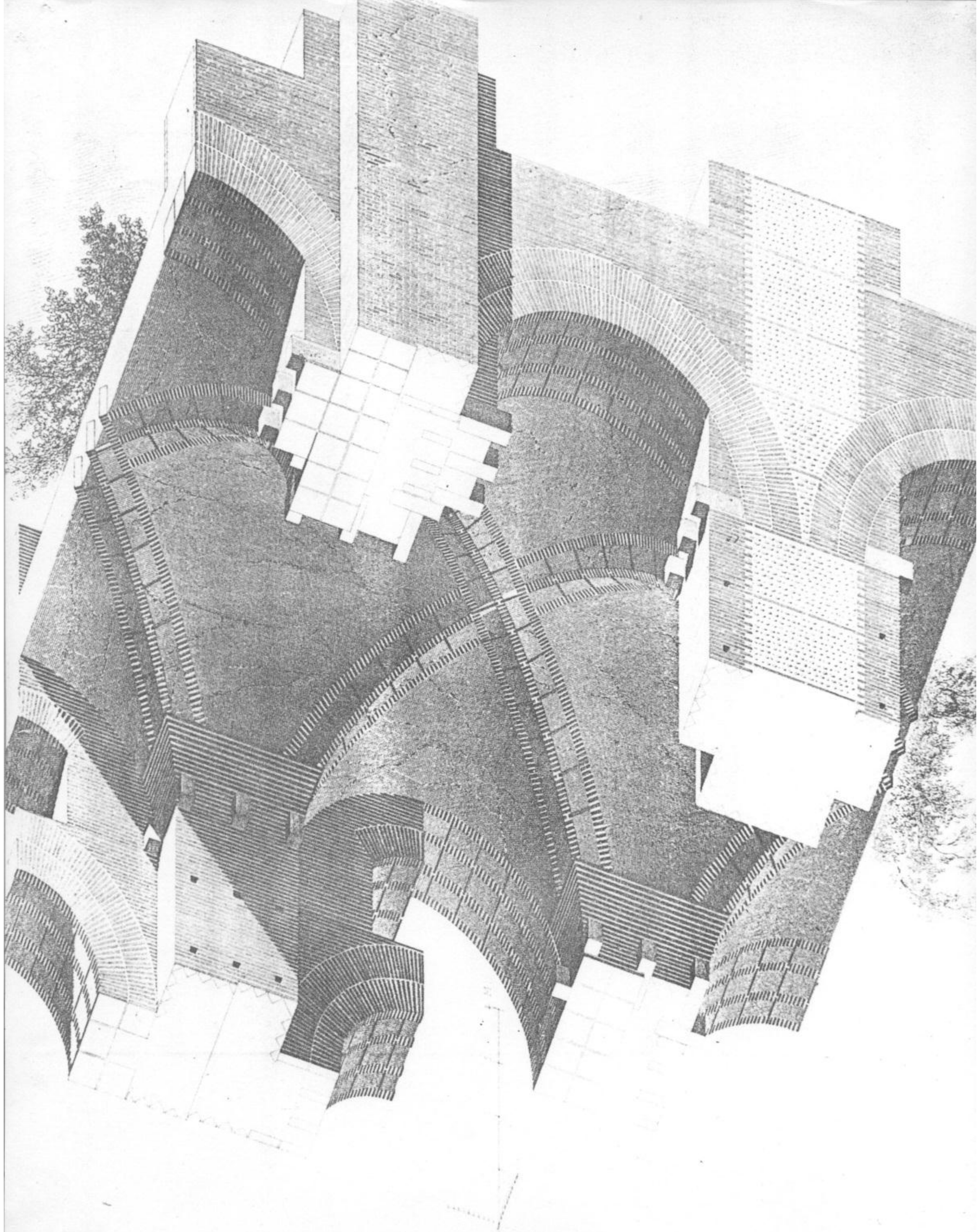
Lecture 10
R. J. VASAVADA.

Topics for discussion :

CLIMATE as one of the important environmental force

- Indegenous forms of shelter build by people basically withstand the negative climatic conditions.
- Shelters are essentially, built responses to climate
- climatic conditions in any context have :
  - Temperature effects
  - light effects
  - wind effects
  - Rain + humidity effects
  - Solar conditions
  - regional
  - orientational
  - topographical
- All the above effects create negative, positive environment which have to be brought down at human comfort levels in a shelter - to facilitate life.
- People devise built-means to tackle any negative climatic effect. These are reflected in the way they built in an indegenous way.
- The way buildings are planned display their instinctive response to develop comfort condition
- Siting of building, plan of a building, form of a building, materials one uses for building, The openings and enclosures of a building, roof of a building, all suggest man's built response to the climate of the region and the environment one wants to create.

ILLUSTRATIONS: 10 pages of ILLUSTRATIONS from a book 'COMMONSENSE ARCHITECTURE' by John Taylor compiles the necessary examples to provide material to explain the above points. Please go through carefully.



View of a Roman monument -
Drawing:Violet-Le-Duc