Građevinski fakultet Osijek
Sveučilište J. J. Strossmayera Osijek

ENGLISH FOR CIVIL ENGINEERS

Lidija Kraljević
Anica Perković
Anamarija Biskupović

Osijek, 2003.

Lidija Kraljević
Anica Perković
Anamarija Biskupović
„ENGLISH FOR CIVIL ENGINEERS“

RECENZENTI:

Doc.dr.sc. Mario Brdar
Doc.dr.sc. Dragan Morić, dipl.ing.građ.

STRUČNI SURADNIK:
Mr.sc.Damir Varevac, dipl.ing.građ.

LEKTOR:
Vesna Zobundžija, prof.

TABLE OF CONTENTS

ENGINEERING PROFESSION
(historical development)

Engineering is one of the oldest occupations in the history of mankind. It is often defined as practical application of theoretical sciences, such as physics or chemistry, for the benefit of mankind.

One of the earliest names that has come down to us is that of Imhotep, the designer of the stepped pyramid at Sakkara in Egypt about 3,000 B.C. This complex represents the first major work in stone. He built the pyramid for Djoser, but it became an architectural model for spiritual ideals of the people of Egypt.

Ancient Greeks used for their temples the post-and-lintel. This type of construction consisted of one horizontal lintel (beam) supported by two vertical posts (columns). The great disadvantage of such a structure was that it did not enable large openings. If the distance between the two vertical columns were two big, the horizontal beam would be subjected to shear and it could break.

Roman architects used arch and vault which enabled much larger openings and more beautiful structures. A great Roman engineer and architect Vitruvius Polio wrote a book about engineering profession of his day. Although the book was written in the first century A.D., the problems that ancient engineers had to deal with, were very similar to those that modern-day engineers still have to encounter.

Many of the early branches of engineering were based not on science but on empirical information, that is, information that depended on observation and experience (trial-and error method) rather than theoretical knowledge. Many of the structures that have survived from ancient times exist because they were built with greater strength than modern standards require.

About the tenth century, people began to form towns and to build up trade or commerce. To trade with other towns, goods had to be carried long distances, across deep valleys and bodies of water. Thus, bridges were needed. But the only people who knew how to build were the monks, for they had preserved the knowledge of past civilizations. So the early medieval bridges were generally built by members of the clergy.

When, towards the end of the fourteenth and the start of the fifteenth centuries, the merchants and craftsmen grew in importance, they started to build bridges. With the new interest in learning and education, there was an increase in the study of science and mathematics – without which bridge building could have never advanced.

During this period the science of engineering was born and the first true civil engineers appeared. Up to that time there had only been military engineering which dealt with temporary structures for military use. Now there was civil engineering dealing with permanent structures for civilian use. Therefore, a more appropriate definition of civil engineering is that it deals with the design and construction of objects that are intended to be stationary. This definition includes buildings and houses, dams, tunnels, bridges, canals, sanitation systems, and the stationary parts of transportation systems: highways, airports, port facilities, and roadbeds for railroads.

Since the beginning of the modern age in the sixteenth and seventeenth centuries, there has been an explosion of knowledge in every scientific field: physics and chemistry, astronomy and psychology… For the first time in the history, scientists could test and verify their theories by using different experimental methods.

There was further increase of scientific knowledge in the period of the Industrial Revolution. That period has given a civil engineer new and stronger materials, modern machines for building structures that had never been possible before and mathematical formulae for calculating all the possible stresses in a structrure. The result was a new number of engineering specialties such as: electrical, mechanical, metallurgical and chemical engineering…

Civil engineering itself has also been divided. Within this field there are the following subdivisions: structural engineering, hydraulic engineering and sanitary or environmental engineering.

COMPREHENSION EXERCISES:

1. Engineering is often defined as……………………………………………………………
2. Who was Imhotep? ……… ……………………………………………………………
3. What were many of the early branches of civil engineering based on?
   ……………………… … ……………………
4. Who built the early medevial bridges?……………………………………………………
5. Military engineering deals with……………… ……………………………………………
6. Copy the definition of civil engineering …………………………………………………
   ………………………………………………………
7. What do civil engineers build? …………………………………………………………
8. How did a civil engineer benefit from the Industrial Revolution?……………………
   ………………………………………………
9. What are the subdivisions within the field of civil engineering? …………………
   ………………………………………………………………………………

CHECK YOUR KNOWLEDGE:

civil engineering –
military engineering –
structural engineering –
hydraulic engineering –
environmental engineering –
permanent structure –
temporary structure –
dam –
port facilities –
bridge building –
stress –

WHAT IS CIVIL ENGINEERING ?

COMPLETE THE TEXT WITH THE MISSING WORDS FROM THE LIST:

(ENVIRONMENTAL ENGINEERING, STRUCTURAL ENGINEERING, HYDRAULIC ENGINEERING, MILITARY ENGINEERING, GEOTECHNICAL ENGINEERING, TRANSPORTATION ENGINEERING, BRIDGE ENGINEERING)

The first branch of engineering was .... Civil engineering was the second engineering profession. In contrast to military work, all infrastructure needed by the society such as road building, canals, or sewer systems, are called civil engineering.

The eighteenth century witnessed the beginning of the Industrial Revolution and in the nineteenth, both scientific research and the practical application of its results have progressed rapidly. Consequently, such explosion of knowledge resulted in the number of scientific and engineering specialties. By the end of the nineteenth century, not only were civil, mechanical, mining and metallurgical engineering recognized, but courses were also being offered in the newer specialties of electrical engineering and chemical engineering. This expansion continued to the present day.

Some define civil engineering as the practical application of theoretical sciences, such as mathematics, chemistry or physics, for the benfit of mankind. A more appropriate definition of civil engineering is that it deals with the design and construction of objects that are intended to be stationary.

Civil engineering involves many disciplines:

.... deals with the design of high-rise office buildings factories, hospitals, high-tech laboratories, bridges, aircrafts, transmission towers, nuclear power plants, and other structures. These structures often have special design requirements such as earthquake-resistance, minimum vibrations, long span, etc. A design must strive not only for high performance, but also low cost and aesthetics.

.... is one of the earliest branches of civil engineering. Irrigation channels thousands years old are found in Mesopotamia, Egypt and China. Modern-day hydraulic engineering involves pipe network for water distribution, reservoirs and its hydraulic structures, water conveying systems, drainage systems, flood forecasting and prevention, sediment transport, pollutant transport and groundwater.

................................used to be called sanitary engineering. Even in ancient times city dwellers knew that it was necessary not only to bring good water into the city for human consumption, but also to collect and discharge bad water away from the city to prevent the spread of disease. The scope of modern-day environmental engineering has beeen much broadened. It deals with chemical, and biological processes in air pollution, clean and waste water treatment, solid waste disposal, surface water and ground water cleanup, acid rain, lake eutrophication, atmosphere ozone depletion, their prevention and remediation.

.... deals with transport of goods and people on land, by air, and by water. It examines traffic patterns and uses signs and signals to regulate and to optimise traffic. It involves pavement, structure, hydraulic drainage, end environmental impact, as the construction of roadways involves all the above issues.

.... involves the foundation of a structure, which is often hidden from sight, but no less important than the structure itself. High-rise buildings often sit on piles that are tens of metres long driven into ground to reach bedrock. A structure with a poor foundation can settle, crack, tilt, and topple. This civil engineering discipline is also needed for retaining walls, slope stabilization, dams, tunnels, and other earth structures.

.... is also a branch of structural engineering. Next time when you drive by a bridge, pay attention to its structure – whether it is an arch, a truss, a suspension, or a cable-stayed bridge. In these amazing structures all the load bearing memebers are exposed.

ANSWER THE QUESTIONS !

1. How can civil engineering be defined ?

___

2. What is a more appropriate definition of civil engineering ?

___

3. Which disciplines does civil engineering involve ?

___

4. Instead of simply recording new vocabulary by writing it down, you can try using the BRAIN MAP which is a very practical and useful way of remembering new words and phrases.

TRANSLATE:

Lijevano željezo i čelik, koji su legure ili mješavine željeza i ugljika, su dva najvažnija metala koja sadrže željezo. Čelik sadrži manju količinu ugljika od lijevanog željeza. Određeni sastojci mogu popraviti osobine čelika. Tako mu, npr. možemo dodati krom da bi smo ga učinili otpornim na koroziju, ili pak volfram radi povećanja njegove tvrdoće.

Meki čelik je vrlo važan građevni materijal koji se često rabi u građevinarstvu. Njegove odlike su slijedeće: ima svojstvo elastičnosti, rastezljiv je, kovan i prilično žilav. Sadrži do 0,25% ugljika, a otpornost na lomljenje, kad je izložen tlačnoj i vlačnoj sili, je 430 do 510 N/mm2. Zbog ovih odlika je vrlo koristan građevni materijal. Upotrebljava se u industriji više od kovanog željeza jer ima nižu cijenu i nešto veću otpornost.

THE PRINCIPAL CONSTRUCTION MATERIALS

The principal construction materials of the earlier times were wood and masonry-brick, stone or tile, earth and mud, and similar materials. The Romans also used a natural cement called pozzolana, made from volcanic ash, that become as hard as stone under water. The Greeks and Romans sometimes used iron rods or clamps to strengthen their buildings. The columns of the Parthenon in Athens, for example, have holes drilled in them for iron bars that have now rusted away.

A brick is baked or dried clay used for building and masonry is the part of a building that is made of stone and cement.

Stone is a hard solid material substance that is not metallic.

Limestone and sandstone were commonly used construction materials of earlier times.

Limestone is a type of white rock, containing calcium, used as a building material and for making cement.

Sandstone is a type of rock formed of grains with sand tightly pressed together.

1. COMPLETE THE SENTENCES WITH THE HELP OF THE TEXT!

1. The principal construction materials were..
2. Pozzolana is ....
3. Iron bars were used by the Romans and Greeks to ....
4. A brick is ....
5. Stone is ....
6. Limestone is ....
7. Sandstone is..

IMPORTANT WORDS !

principal construction materials -
limestone -
brick -
mud -
sandstone -
pozzolana -
iron bar -

MODERN CONSTRUCTION MATERIALS
STEEL & CONCRETE

Steel is a strong, hard material, basically an alloy of carbon anad a small amount of carbon. Henry Bessemer (1813 – 1898) is the man whose name we associate today with the major process of producing steel. It was his discovery of a process for making steel cheap which led to its use in the construction industry. Bessemer initially encountered difficulties in commercially producing steel by his method because he was unaware of the importance of high quality iron ore to the process. Eventually he was successful and mass production of steel began.

Modern cement, called Portland cement, was invented in 1824. It is a mixture of limestone and clay, which is heated and then ground into powder. It is mixed at or near the construction site with sand, aggregate (small stone, crushed rock, or gravel), and water to make **concrete**. Different proportions of the ingredients produce concrete with different strength and weight. Concrete is very versatile; it can be poured, pumped, or even sprayed into all kinds of shapes. Whereas steel has great tensile strength, concrete has great strength under compression. Thus, the two substances complement each other.

They also complement each other in another way; they have almost the same rate of expansion and contraction. They therefore can work together in situations where both compression and tension are factors. Steel rods are embedded in concrete to make reinforced concrete in concrete beams or structures where tension will develop. Concrete and steel also form such a strong bond that steel cannot slip within the concrete. Another advantage is that steel does not rust in concrete.

1.ANSWER THW QUESTIONS:

1. Who was H. Bessemer ? ______
2. What is steel ? ______
3. What is Portland cement ? ______
4. How do we get concrete ? ______
5. Why is concrete versatile ? ______
6. What are the two great advantages of steel and concrete

   ______
7. Why do we combine these two materials ?

   ______

2.CONNECT THE WORDS !

rod	vapnenac
ore	prah
alloy	ruda
limestone	otpornost na vlak
clay	šipka
powder	legura
gravel	šljunak
tensile strength	glina

CONCRETE DESIGN AND CONSTRUCTION

Concrete made with Portland cement is widely used as a construction material because of its many favorable characteristics. One of the most important is a high strength-cost ratio in many applications. Another is that concrete, while plastic, may be cast in forms easily at ordinary temperatures to produce almost any desired shape. The exposed face may be developed into a smooth or rough, hard surface, capable of withstanding the wear of truck or airplane traffic, or it may be treated to create desired architectural effects. In addition, concrete has high resistance to fire and penetration of water.

But concrete has also disadvantages. An important one is that quality control is sometimes not so good as for other construction materials, because concrete often is manufactured in the field under conditions where responsibility for its product cannot be pinpointed. Another is that concrete is relatively brittle material. Its tensile strength is small compared with its strength. This disadvantage, however, can be offset by reinforcing concrete with steel. The combination of the two materials, reinforced concrete, possesses many of the best properties of each. It finds use in a wide variety of construction, including building frames, floors, roofs, and walls, bridges, pavements, piles, dams, tanks... For a specific structure, it is economical to use a concrete that has exactly the characteristics needed. For example, concrete for a building frame should have high compressive strength, whereas concrete for a dam, should be durable and watertight, and strength can be relatively small.

Workability is an important property for many applications of concrete. Difficult to evaluate, workability, in essence, is the ease with which the ingredients can be mixed and the resulting mix handled, transported, and placed with little loss in homogenity. One characteristic of workability that engineers frequently try to measure is consistency, or fluidity.

Durability is another important property of concrete. Concrete should be capable of standing the weathering, chemical action, and wear to which it will be subjected in service. Much of the weather damage sustained by concrete is attributable to cycles of freezing and thawing.

Watertightness is an important property of concrete that can often be improved by reducing the amount of water in the mix. Excess water leaves voids and cavities after evaporation, and if they are interconnected, water can penetrate or pass through the concrete. Entrained air usually increases watertightness, as also does prolonged thorough curing.

Volume change is another characteristic of concrete that should be taken into account. Expansion due to chemical reactions between the ingredients of concrete may cause buckling, and drying shrinkage may cause cracking.

PRESTRESSED CONCRETE

Prestressed concrete is an improved form of reinforcement. Steel rods are bent into the shapes to give them the necessary degreee of tensile strength. They are then used to prestress concrete, usually by one or two methods. The first is to leave the channels in a concrete beam that corresponds to the shapes of the steel rods. When the rods are run through the channels, they are then bonded to the concrete by filling the channels with grout, a thin mortar or binding agent. In the other (and more common) method, the prestressed steel rods are placed in the lower part of a form that corresponds to the shape of the finished structure, and the concrete is poured around them.

The availability of steel and concrete, together with the elevator, which was also developed in the nineteenth century, have made possible the most characteristic kind of modern structure: the steel or concrete frame building. Not only towering modern skyscrapers, but also many less gigantic and spectecular buildings have a skeleton of steel or concrete that bears the weight of the structure.

Until this type of construction became possible, the exterior walls – called bearing walls – had to carry the weight of the building. This ment that the walls on the lower floors of a tall building had to be tremendously thick. The Old Pulitzer Building in New York had walls that were nine and one-half feet thick at the base.

Since the weight of modern structure of this type is carried by the steel or concrete frame, the walls do not support the building. They have become curtain walls, which keep out the weather and let in the light. In the earlier steel frame building, the curtain walls were generally made of masonry; they had the solid look of bearing walls.

Today, however, curtain walls are often made of lightweight materials such as glass, aluminium, or plastic, in various combinations.

Prestressed concrete has made it possible to develop buildings with unusual shapes, like some of the modern sport arenas, with large spaces unbroken by any obstructing supports.

The current tendency is to develop lighter materials.

Aluminium, for example, weighs much less than steel but has many of the same properties. It has already been used for bridge construction and for the framework of a few buildings.

EXERCISES:

1. CHECK YOUR VOCABULARY !

prestressed concrete –
reinforcement –
grout –
mortar –
binding agent –
elevator –
steel/concrete frame building –
exterior walls –
bearing walls –
curtain walls –

2. TRANSLATE THE TEXT !

3. COMPLETE THE DEFINITIONS !

Prestressed concrete is an improved form of reinforcement.................
Bearing walls are walls which carry the weight of the [illegible]..........
Curtain walls are walls which keep out the weather and [illegible] the light..........

4. FILL IN THE GAPS!

1. Steel rods are bonded to the concrete with ....grout
2. There are two different methods for Prestressing......... concrete.
3. Bearing.................. walls are usually very massive.
4. In prestressed concrete steel is prestressed to give it the necessary......tensile strength
5. ... walls keep in the light. Curtain
6. Prestressed concrete is a better form of ....reinforcement
7. The availability of steel and concrete and the invention of elevator have enabled one of the most characteristic kinds of a modern structure...the steel or concrete frame building.........

WOOD DESIGN & CONSTRUCTION

Wood is remarkable for its beauty, versatility, strength, durability, and workability. It possesses a high strength-to-weight ratio. It has flexibility. It is resistant to many chemicals that are highly corrosive to other materials. It has high shock-absorption capacity. It has good wearing qualities, particularly on its grain. It can be bent easily to sharp curvature. Wood can be used in both wet and dry applications. It performs well at low temperatures. It withstands substantial overloads for short periods. It has low electrical and thermal conductance. It resists the deteriorating action of many chemicals that are extremely corrosive to other building materials.

As a consequence of its origin, wood as a building material has inherent characteristics with which users should be familiar. For example, although cut simultaneously from trees growing side by side in a forest, two boards of the same species and size may do not have the same strength. The task of describing this nonhomogenous material, with its variable biological nature, is not easy.

With a better understanding of wood now possible, the availability of sound structural designd criteria, and development of economical manufacturing processes, greater and more efficient use is being made of wood for structural purposes.

Wood differs in several significant ways from other building materials. Its cellular structure is responsible, to a considerable degree, for this. Structural materials are essentially isotropic, with nearly equal properties in all directions, whereas wood has three principal grain directions-longitudinal, radial and tangential. Parallel to the grain, wood possesses high strength and stiffness. Across the grain, strength is much lower.

Wood undergoes dimensional changes from causes different from those in most other structural materials. Significant dimensional changes (swelling and shrinkage), for instance, occur because of grain or loss in moisture.

JOIN THE EXPRESSIONS TO THE MATERIAL THEY REFER TO !
(Some of them may refer to both materials !)

WOOD
CONCRETE

cellular structure
high resistence to fire
manufactured in the field
grain direction
strenght – cost ratio
inherent characterisitics
aggregates
compressive strength
versatile

MECHANICAL PROPERTIES OF MATERIALS

The important mechanical properties of structural materials are: elasticity, plasticity, ductility, brittleness, proportionality of stress and strain, stiffness, strength, endurance, toughness and hardness.

Elasticity and plasticity. Elasticity is that property of a body which enables it to recover its original size and shape after deformation. Plasticity is that property of a body which enables it to retain its deformation after the application and release of a load. Plasticity thus is the opposite of elasticity.

Ductility and brittleness. Ductile materials are capable of undergoing great plastic deformation when subjected to tensile loads. Thus ductility is a property of many metals but rarely is found in nonmetals. Brittleness is the opposite of ductility and brittle materials undergo but little plastic deformation when loaded to failure. Most of the nonmetallic materials of construction are classed as brittle materials. Soft steel, brass and aluminium are examples of ductile metals. Cast iron concrete and brick are examples of brittle materials.

Malleable materials are capable of being beaten into thin shapes. Evidently materials that are ductile are also likely to be malleable. Gold, thin, and lead are examples of malleable metals.

Flexible materials are capable of being bent without breaking. Malleable iron is more flexible than gray iron and soft steel is more flexible than hard steel.

Hardness is a quality that has been defined in a number of arbitrary ways. The most common scale of hardness used for engineering materials is the indentation hardness, like the Brunell hardness, which is measured by the indentation of standard load.

Resilient materials are those which are capable of absorbing large amounts of energy without suffering permanent deformation. Evidently the combination of low limit would produce high resilient materials.

Tough materials are capable of absorbing large amount of energy before rupture. Toughness is evidently dependent upon a combination of high strength and high ductility or high strength and high flexibility. Toughness measures the ability to absorb a shock or sudden blow without rupture.

WHICH IS THE OPPOSITE WORD ?

elastic - ……., brittle- ………., hard- …………, tough- ………….., stiff - …………

GIVE AT LEAST ONE EXAMPLE OF A MATERIAL WHICH IS …

elastic, plastic, ductile, brittle, malleable, flexible, hard, resilient, tough

GEOLOGICAL SURVEY

Geophysics is the scientific study of the earth's physical activities. It comprises some other sciences, such as meteorology, gravimetry, geomagnetology, seismology, hydrology, radiometry, etc.

Petrology is the scientific study of rocks and minerals, their composition, structure and formation.

Geology is the scientific study of the earth, including the origin, structure and history of the rocks, soil, etc. of which it is composed.

In addition to measuring surface for civil engineering projects, it is often necessary to make a geological survey.

Geological survey involves determining the composition of the soil and rock that underlie the surface at the construction site. The nature of the soil, the depth at which bedrock is located, and the existence of faults or underground streams are subsurface factors that help civil engineers determine the type and size of the structural foundations or the weight of the structure that can rest on them. In some areas, these can be critical factors. For example, Mexico city rests on a lake bed with no bedrock near the surface; it is also located in an earthquake zone. The height and weight of the buildings must therefore be carefully calculated so that they will not exceed the limits that are imposed by the site.

Geological samples are most often obtained by borings, in which hollow drills bring up cores consisting of the different layers. Other devices that are used in geological surveys are gravimeters and magnetometers. The gravimeter measures the earth's gravitational pull; heavier rocks like granite exert a stronger pull than lighter ones like limestone. The magnetometer measures the strength of the earth's magnetic field. Again, the denser the rock, the more magnetic force it exerts. The third instrument is the seismograph,which measures vibrations, or seismic waves, within the eart. It is the same instrument that is used to detect and record earthquakes. In a geological survey, it is used by setting off small, man-made earthquakes. The waves created by blast of dynamite buried in the ground reflect the different kinds of rock under the surface; hard or dense rocks reflect the waves more strongly than soft or porous rocks.

1. TRANSLATE THE TEXT
2. MAKE COLLOCATIONS:

construction	pull
geological	site
underground	survey
gravitational	stream
seismic	wave
earth's	origin

FOUNDATIONS

Foundations (footings) are bases, usually of concrete, placed on the ground so as to spread a vertical load over it. Bases which carry horizontal load, for example under arches, are usually called abutments.

A foundation may be built in one of many different materials. It may be of timber (below ground water level) or of steel joints encased in concrete, of reinforced concrete or plain concrete without reinforcement, or for breakwater in the sea merely of rock. Structures built on strong rock generally need no foundation since rock is usually as strong as concrete, and goes much deeper. All that is needed on rock is a little concrete or mortar to make the surface level.

The main problem in the design of the foundations of a multi-story building under which the soil settles is to keep the total settlement of the building within reasonable limits, but specially to see the relative settlement from one column to the next is not great. If one column settles much more than its neighbour, the building will certainly crack and may look as if it is breaking in pieces. Obviously every structural design wishes to avoid this impression, even if it is a wrong one, as it often is.

The design of a multi-story building on compressible soil is difficult and therefore extremely interesting. Compressible soils are like sponge, sinking most where the pressure is greatest and the load is largest. Thus even if all the foundations are designed for the same bearing pressure the largest foundation will sink the most because it has the load. The exact calculation of these different bearing pressures is extremely difficult but at least this is now the aim of foundation engineers.

One solution, which however is rather expensive because it may involve a deep excavation, is to dig out a quantity of soil which weighs exactly the same as the dead load of the building plus the quantity of live load which is likely to be on it. This depth of it should be such as to make sure that the loaded building will be carrying no more load after the structure has been put up than it carried before, there will in theory be no general settlement. In fact, however, for various reasons some foundations will sink.

Foundation engineering is the science of founding structures, that is, the techniques of transmitting load to the foundation material, which may be rock or soil. Site investigation always precedes a foundation design. Such an investigation may vary from a superficial inspection, allied with examination involving the testing of samples of the foundation material. The primary object of all these activities is to determine the safe bearing power of this stratum. Another important factor usually determined at the same time is the ground water level. The most usual construction materials are wood, masonry, concrete, and steel. The aggressive influences of water, soil, or rock on these materials have to be taken into account when selecting such materials for use.

1. COPY AND TRANSLATE THE SENTENCES

1. Foundations are...
2. The main problem in the design of the foundations...............................
3. Compressible soils are like...
4. Foundation engineering is...
5. Site investigation..
6. Such an investigation..

2. WRITE QUESTIONS TO THE FOLLOWING ANSWERS

1. Of timber, steel, reinforced concrete.
2. To keep the total settlement of the building within reasonable limits.
3. They are like sponge.
4. To determine the depth at which a satisfactory bearing stratum occurs and the safe bearing power of this stratum.
5. The ground water level.
6. Because water, soil or rock can have aggressive influence on these materials.

3. INSERT THE MISSING PREPOSITION

1. The beam is subject … bending.
2. These specifications provide … a minimum thickness of metal.
3. Style is dependant … the reader.
4. A series of observations should be made … different conditions.
5. The builders have been trying to cut down … the amount of hand labor needed at the site.
6. Modern builders are interested … improving tha space inside their building.
7. A modern building has taken many steps … producing a comortable and pleasant indoor environment.
8. The engineer is interested … the effect of the wearing surface.
9. What is this project based … ?

TYPES OF FOUNDATIONS

The term rock and stone are often used synonymously, but there is actually some distinction between them. Both of these terms apply to the same material but, in general, if geological formations are being considered, the term rock is used while smaller pieces of rock are called stone. However, the distinction between rock and stone is not always made. Rock is divided into three classes according to their method of formation. These classes are igneous plutonic, sedimentary, and metamorphic. They are also divided into classes according to their chemical composition. If rock is found within a few feet under the surface of the ground or if it is within economic reach, it is used to support the foundations. This applies especially to structures which only partly destroyed , endanger life and property, as for instance, dams. But the mere fact that a structure is built on rock does not guarantee its stability. Stability means that the foundation will neither overturn nor slide under the load of the superstructure, the active earth pressure, the water pressure, or its own weight and that no shear failure will occur. Before the foundation plans are prepared, an investigation should be made to determine the character of the foundation material, which will be required to support the structure. In natural position, soil serves as the support for the foundations of most structures, whereas the foundations for some of the major structures are carried to rock if rock is readily accessible.

For constructing the substructure, an excavation must be provided. Its size, depth, for the excavation, etc., and shape are governed by the dimensions of the substructure.

Types of foundations. The type of foundation must be selected with due regard to the superstructure and its loads (permanent load and live load), the properties of the foundation material and the elevation of the ground water table. If the bearing stratum occurs within a few feet of the structure of the ground, a shallow footing is advisable, which however, must be protected against frost.

When the bearing stratum lies at some depth below the ground surface, or below water and the loads are heavy, deep foundations are often provided.

If the bearing stratum is some distance below the ground level, or below the bottom of the excavation for the structure to be supported, piles are driven into the bearing stratum (or moulded in situ)instead of taking out an extensive and deep excavation. Therefore, piles generally act as columns to transmit the weight of the structure from an upper level through an intervening stratum of soft ground to a harder stratum (which may be rock, compact gravel or sand, or firm clay), at a lower level.

The term caisson is derived from the French word, caisse, meaning box. There are three forms of caissons used in constructing foundations under water, i.e. the box caisson (open at the top and closed at the bottom), the open caisson (open at the top and the bottom), and pneumatic caisson (open at the bottom and closed at the top and utilizing compressed air).

Box caissons are used in constructing bridge foundations under water. The caissson, which may be constructed of timber, concrete, or steel, is towed into position, filled with concrete or stone masonry and sunk until it rests on the river bottom which has been prepared to receive it. Box caissons are not applicable for buildings.

EXERCISES:

1. ANSWER THE QUESTIONS:
2. When is the term rock used ?
3. How are smaller pieces of rock called ?
4. When is rock used to support the foundations ?
5. What does stability mean ?
6. What does the selection of the type of foundation depend on?
7. How does the bearing stratum influence the type of the foundation ?
8. Explain when and how are box caissons used ?

2. COMBINE THE PARTS OF SENTENCES :

a) The caisson	examine the bearing stratum.
b) The base which carries horizontal loads	is used to construct under water.
c) Foundation engineering	forms the base of a building.
d) Site investigations	deals with the transmission of load.
e)The foundation	is usually called abutment.

3. CHOOSE THE WORD WITH THE SAME OR SIMILAR MEANING:

1. Stratum
   a) layer
   b) depth
   c) ground level

2. Slide
   a) to move smoothly along an even, polished or slippery surface
   b) to lose balance and fall
   c) to move quietly, quickly or easily

3. Pile
   a) support
   b) column
   c) stick

CIVIL ENGINEERING SUBDIVISIONS

STRUCTURAL ENGINEERING

A person who is known as a „building orthopedic specialist" is known as a structural engineer. It is he who deals with the skeleton of a structure, observing what tha structure is constructed of, how it beheaves, and how that structure can be made by enhancing its physical components.There are five major areas in which all structural engineers deal:

1. the design of structures
2. the distribution of forces throughout the structure and what those forces will be like over the entire life span of the structure
3. the transmission of the loads
4. the selection of proper building materials
5. proportion of all the physical elements involved to ensure long life of the structure. Structural engineering is composed of more than five aspects, however. Much of what is done in this field is accomplished during research. In the lab or site, structural engineers are continuosly analysing the strength and stability of materials (primary steel and consrete), how these materials fatigue over time, and their reliability in existing structures. Outside of research, the sructural engineer is responsible for the safe and ethical construction of his projects.

HYDRAULIC ENGINNERING

Hydraulics is the science that deals with the flow and control of water and other fluids. Among mankind's oldest works are irrigation, water supply systems and canals for navigation. A dam is a barrier constructed across a stream or river to impound water and raise its level. The most common reason for building dams are to concentrate the natural fall of a river at a given site, thus making it possible to generate electricity, to direct water from rivers into canals, and irrigation and water-supply systems, to increase river depths for navigational purposes, to control water flow during times of floods and droughts, and to create artificial lakes for recreational use. Before a design and construction of a dam can begin, an extensive survey and study of the site must be made. This survey examines topographical features of the area, as well as hydraulic features of the stream or river that is being dammed. It is also necessary to study the site to see whether the dam can be constructed with the use of cofferdams or whether the flow of the river must be diverted. When it si necessary to divert the river, one technique is to dig tunnels for the channel, another is to excavate a temporary channel for the river around the site.

The velocity and pressure of the water that is being blocked are important factors in the design of a dam. Another factor is the possibility of seepage under the foundations, often requiring special protective features in the design. Seepage is the slow leaking of water under the foundations. Often requiring special protective features in the design. Seepage is slow leaking of water through a porous material, such as earth or some kinds of rock like limestone or sandstone.

TRANSPORTATION ENGINEERING

Transportation has always been one of the most important aspects of civil engineering. Modern highways are still built according to the principles laid down in the eighteenth and nineteenth centuries by a Frenchman Pierre Tresageut, an Englishman Telford, and a Scot, John L.McAdam, whose name has passed into English in the words macadam, macadamize, and tarmac. These men designed the first modern roads that had a firm footing, the surface on which the foundation rested. Their roads aslo included good drainage and a wearing surface (the top level that directly receives the wear of traffic) that could not be penetrated by water. McAdam realized that the soil itself could bear the weight of the road when it was compacted or pressed down, as long as it remained dry. He was able therefore to eliminate the heavy cost of the stone foundation by laying a base course of crushed stone on the top of a compacted footing. Basically, the roadbuilding had improved in only two ways in the twentieth century. The first improvement involves the use of concrete for the wearing surface. The other is traffic engineering, which has produced the modern express highways, or freeways that has only limited access and maximum safety controls. The angular intersections common on older roads have beel eliminated in favor of cloverleaf interchanges or other with even more complicated designs. Extreme curves or steep slopes are minimized so that the traffic can continue to move without slowing down.

SANITARY / ENVIRONMENTAL ENGINEERING

Environmental engineering is concerned with providing clean, safe water supply system fo towns, cities, and rural areas. It is also concerned with disposing of excess water and waste materials by means of sewer systems. Many aspects of environmental engineering are idrectly related to hydraulic engineering. A water supply for a town usually includes a storage reservoir at the source of the supply, a pipeline from the storage reservoir to the distribution reservoir near the town, and finally the distribution pipes buried in the streets, taking water to the houses, shops, factories, and offices. The main equipment is, thus, the two reservoirs and the pipeline between them.

BRIDGE BUILDING

Bridge is a structure designed to provide continuous passage over an obstacle (wateways, deep valleys, roads, and other transportation routes). Bridges may also carry water, support power cables, or telecommunication lines. The basic beam bridge, a simple beam over a span, was strengthened by adding support piers underneath and by reinforcing the structure with elaborate scaffolding called a truss. After the invention of a practical process for converting cast iron into steel, many large –scale steel suspension bridges were constructed over major waterways. In the late 19th century, engineers began to experiment with concrete reinforced with steel bars for added strength. More recently, reinforced concrete has been combined with steel girders, which are solid beams that extand across a span. Engineers must consider several factors when designing bridge. They consider the distance to be crossed and the physical nature of the building site (the geometry of approaches, the strength of the ground, and the depth to firm bedrock), temperature, and environmental conditions also determine the best bridge design for a practical situation.

TUNNEL BUILDING

A tunnel is an elongate, narrow, essentially linear excavated underground opening with a length greatly exceeding his width or height. Tunnels are used for highway traffic, railroads, and subways; to transport water, sewage, oil and gas; to divert rivers around dam sites while the dam is being built; and for military and civil-defense purposes.

The building of a tunnel is known as driving a tunnel and involves advancing the passageway by blasting or boring and excavating. Tunnels through mountains or under water are usually worked from the two oppostie ends, or faces, of the passage. In the construction of a very long tunnel, vertical shafts may be dug at convenient intervals to excavate from more than two points. Improved boring and drilling machines now allow a tunnel to be driven four or five times faster than it was possible with older techniques.

The rock drill that is driven by compressed air has helped most in reducing the time of tunneling in recent years. A number of these drills may be positioned on wheeled vehicles, called jumbos, and rolled to the face of the tunnel. Another recently developed tunneling machine is a mole – a long machine with a circular cutting head that rotates against the face of the tunnel. Attached to the cutting head is a series of steel disk cutters that gouge out the rock on the face as the machine rotates and is pushed forward by hydraulic power. Some other tunneling machines are pneumatic drills , tunneling shields, conveyor belts, lasers etc.

STRUCTURAL FORMS

To provide a cover over a sheltered space, and permit openings in the walls that surround it, builders have developed four techniques consistent with the balance between gravity, form, and material. These building techniques are post and lintel, arch and vault, truss and cantilever construction.

POST AND LINTEL

In this type of a construction, the post (or column) carries only a vertical weight, or load, and is therefore under compression, and lintel (or beam) is bent by the loads acting transversely to its axis. Therefore, the post must have compressive strength and the beam must have bending strength. Both wood and stone were used in early examples of this type of construction, although the limited bending of stone dictated the close column space which is apperent in Greek temples. For example, in the Parthenon in Athens, the space between columns is approximately equal to the column diameter. Today modern building materials such as steel skyscraper, for instance, consists of beams and columns in a three-dimensional post and lintel network or grid. Just as a house of cards can support vertical loads but topple under winds or earthquakes, both of which impose horizontal forces. In tall modern buildings lateral instability becomes a significant factor. To provide the necessary lateral resistance a rigid connection must be made between the vertical column and horizontal beam. This creates a rigid frame which is used to achieve lateral stability in skyscraper construction.

ARCH AND VAULT

The arch, which is characteristically a masonry type of construction, undoubtedly had its origin in Mesopotamia, a land of brick buildings. Arches consist of masonry blocks in the form of a curved line. In principle, each wedge-shaped masonry block cannot fall inward without pushing the others out; thus the whole arch form remains stable as long as a force is applied at the base to keep it from spreading. This force is called a horizontal thrust. A continuos series of arches is known as a vault. The form of Roman arch or vault is generally semicircular for reasons of geometric simplicity. As a result all wedge-shaped stones are identical; their curved lines are equidistant from the center of the circle, and their straight edges lie on equally spaced lines radiating from the center. This type of semicircular arch was widely used by the Romans. The Gothic arch, which is characterized by its pointed shape, evolved in France in the 12th century. This form characterizes some of the most magnificient churches of the early Renaissance period . The fork of the Gothic arch is superior to the Roman arch because of its greater structural clarity which closely approches the shape of an ideal arch.

TRUSS & CANTILEVER

TRUSS

The simpliest form of a truss is a triangle consisting of three bars. This elementary truss form undoubtedly grew out of the use of the gabled roof for small houses and churches. It is a geometrically rigid form, because none of its angles can change without changing the length of its sides. Each element in a truss is subject to either tension or compression; in the simple triangular truss, the rafters are in compression and the tie rod is in tension. The elementary triangular truss is limited to spanning relatively short distances because each slanting member is long compared to the span. This drawbeck was recognized by Andrea Palladio in the 16 century. His design for a truss bridge utilized principle that if a single triangle is rigid, combinations of triangles are also rigid. By arranging short lengths of triangles to form complex trusses, almost any distance can be spanned.

CANTILEVER

In canitlever construction, building elements are projected outward from a fixed support. Cantilever building elements from a wall or other fixed support permit projecting part of a building beyond the ground-level construction to gain more living area above, as in many of the Renaissance town houses. The cantilever is much used in modern buildings as a result of the availability of steel and reinforced concrete. It is a simple matter in a concrete apartment building to create a cantilevered balcony when the balcony slab is merely continuation of the interior slab. In a steel-framed building, beams can project beyond columns to permit the face of the building to be a curtain wall with large glass areas.

JOB PLANNING & MANAGEMENT

This chapter deals with the planning that is necessary prior to starting actual construction on a project. Such planning should facilitate the construction by establishing:

1. The time for delivering materials
2. The types, quantities and numbers of laborers needed and the period during which they will be needed
3. The extent to which financial aid, if any, will be needed
4. The time required to complete the project

A contractor should do some of this planning prior to bidding a project, since planning frequently will reveal factors which will affect the cost of the project, and thus will influence the amounts shown in a bid.

Construction activities. Most projects are divided into construction activities to facilitate job planning. A construction activity is a portion of a project, which may be performed by a classification of laborers or pehaps a single type of equipment. For example, in constructing a reinforced-concrete retaining wall the project might be divided into the following activities:

1. Excavate earth, machine.
2. Excavate earth, hand.
3. Build forms.
4. Place reinforcing steel.
5. Place concrete.
6. Cure concrete.
7. Remove forms.
8. Finish concrete surface.
9. Backfill with earth.

In planning the construction of a highway for a new location the project might be divided into the following activities:

1. Move to the project and set up the plant.
2. Clear and grub the right of way.
3. Perform the earthwork, cut and fill.
4. Excavate the base material.
5. Place the base material.
6. Place the pavement.
7. Shape the shoulders.
8. Clean up and remove the plant.

In order to estimate the progress in constructing the project, the job planner should determine the quantity of work to be done for each activity expressed in an appropriate unit. Then he should estimate the probable rate, at which the work will be performed, allowing for estimated loss in time owing to bad weather or any other cause. From this information it will be possible to estimate starting date and completion date for each activity. The estimated starting date and completion date for each activity should be determined. In scheduling the activities the job planner should consider the desirable sequential realtionships between the activities. For example, in constructing a concrete foundation unit it will be necessary to complete the excavation before concrete can be placed.

Each activity should be identified by a symbol or an appropirate description or both, and listed in a column form, with the duration of the activity, together with the activities, which immediately precede and follow it. Then the inter-relationship of activities can be indicated by a network or arrow diagram.

Scheduling resources. If a construction on a project is to proceed efficiently and at the scheduled rates, it is necessary to know accurately the types and quantities of resources that will be needed and the dates on which they will be needed. Resources include materials, equipment, and the labor, by classification and quantities. An analysis of the information will enable the project planner to know in advance whereat resources will be needed in arrange for them to be avaliable when they are needed.

Delivering materilas. The arrow diagram or the time-grid may be used as a guide in specifying the delivery dates for materials. Materials should be delivered to a project before they are needed. However, excessively early delivery is not desirable because of the possibility that materials might deteriorate or might congeste working areas in which storage space is limited.

Scheduling equipment use. An equipment use schedule is prepared before the project is started to establish the types, qunatities, and dates for equipment need.

Scheduling laborers. Employment schedule may be used in determining the classification and numbers of laborers required for a project.

APPENDIX

DO WE STILL NEED SKYSCRAPERS ?

Our distant forebears could create remarkably tall structures by exploiting the compressive strength of stone and brick, but the masonry piles they constructed in this way contained little usable interior space. At 146 meters, the Great Pyramid of Cheops is a vivid expression of the ruler's power, but inside it is mostly solid rock. On a square base of 230 meters, it encloses the King's Chamber, which is just five meters across.

The Industrial Revolution eventually provided ways to open up the interiors of tall towers and put large numbers of people inside. Nineteenth-century architects found that they could achieve greatly improved ratio of open floor area to solid construction by using steel and reinforced concrete framing and thin curtain walls. They could employ mechanical elevators to provide rapid vertical circulation. And they could integrate incresingly sophisticated mechanical systems to heat, ventilate and cool growing amounts of interior space.

These contraptions found a ready market because they satisfied industrial capitalism's growing need to bring armies of office workers together at locations where they could conveniently interact with one another, gain access to files and other work materials, and be supervised by their bosses.

But there were natural limits to this upward extension of skyscrapers, just as there are constraints on the size of living organism. Floor and wind loads, people, water and supplies must ultimately be transferred to the ground, so the higher you go, the more of the floor area must be occupied by structural supports, elevators and service ducts. At some point it becomes uneconomical to add additonal floors; the diminishing increment of usable floor area does not justify the inreasing increment of cost.

Urban planning and design considerations constrain height as well. Tall buildings have some unwelcome effects at ground level; they cast long shadows, blot out the sky and sometimes create dangerous and unpleasant blasts of wind. And they generate pedestrian and automobile traffic that strains the capacity of surrounding streets. To control these effects, planning authorities typically impose limits on height and on the ratio of floor area to the ground area. Consequently, exceptionally tall buildings have always been expensive, rare and conspicious. So organisations can effectively draw attention to themselves and express their power and prestige by finding ways to construct the loftiest skyscrapers in town, in the nation or maybe even in the world.

At the same time the Digital Revolution has been reducing the need to bring office workers together, face-to-face, in expensive downtown locations. Efficient telecommunications have diminished the importance of centrality and correspondingly increased the attractiveness of less expensive suburban sites that are more convenient to the labor force. Digital storage and computer networks have increasingly supported decentralized remote access to databases rather than relianace on centralized paper files. And businesses are discovering that their marketing and public-relations purposes may now be better served by slick World Wide Web pages on the Internet and Superbowl advertising spots than by investments in monumental architecture on expensive urban areas.

We now find, more and more, that powerful corporations occupy relatively unobtrusive, low- or medium-rise suburban officer campuses rather than flashy downtown towers. Nike's campus in Beaverton, Ore., is pretty hard to find, but www. nike.com is not.

Does that mean that skyscrapers are now dinosaurs ? Have they finally had their day ? Not quite, as a visit to the fancy bar high atop Hong Kong's prestigious Peninsula Hotel will confirm. In the 21^{st} century, as in the time of Cheops, there will undoubtedly be taller and taller buildings, built at greater effort and often without real economic justification, because the rich and powerful will still sometimes find satisfaction in traditional ways to demonstrate that they are on the top of the heap.

abridged from Scientific American, Dec. 1997
by William J. Mitchell,
dean of the School of Architecture & Planning
at the Massachussetts Institute of Technology

EXERCISES:

1. TRANSLATE THE TEXT
2. CAN YOU THINK OF SOME OTHER ADVANTAGES NAD DISADVANTAGES OF SKYSCRAPERS ?

GREEN ARCHITECTURE IN THE 21ST CENTURY

It seems that the green building movement has taken roots since its inception at the first Earth Day in 1970, and seems to be growing at a very strong pace. And why would anyone doubt it ? Green building makes sense from all standpoints. Its concerns focus on the environment, economy, public health and comfort. It is about quality, durability, and longevity. It is about environmental consciousness, energy saving design, the use of nontoxic materials, and the use of the efficient techniques to construct a more cost-effective house.

Some of the trends were brought on by economic factors including the rise in wood prices, and the decline in wood quality due to the lack of properly managed forests. Alternatives, including engineered lumber, made from wood chips or strands laminated together have become commonplace in the building site. These materials have proved to be stronger, straighter, dimensionally stable, and usually lighter than solid wood alternatives.

At the forefront, Austin, Texas' Green Building Program has had enormous success in its past six years. The key to this program success is in its marketing approach, encouraging professionals to use green building methods and materials. Austin's Green Building Program focuses on four principals, including:

1. to conserve energy, water, and other natural resources
2. to preserve the health of our environment
3. to strengthen our local economy
4. to promote a high quality of life for the citizens of Austin.

These same principals can be paralleled to define what is now green building. In the simplest terms, green building is organized around four main systems.

1. Water: its collection, use nad reuse.
2. Energy: its source, use nad reuse.
3. Materials: their source, content, composition and the manufacturing processes used to create them.
4. Waste: its disposal, recyclability and resource efficiency.

These principals revolve around conservation of energy, materials, resources, and finances, preserving environmental health, strenghtening the local economy and promoting a high quality of life.

In the community, architects such as Andres Duany and Elisabeth Plater-Zyberk have worked to create communities based on lessons learned from old fashioned towns and neighborhoods. Some experts feel that more village-like streets will appear. This will allow residents to live, work and shop within a short walking distance. With less emphasis on the use of the car, parking will be tucked away, allowing for small parks, public squares, and street seating to enliven ones everyday experience.

In the home, flexibility, efficiency, and ecology will be the driving force of home technology in the 21s^{t} century. Homes will be smaller, with a more efficient plan based on flexible design, allowing for multiple uses within the same space. These flexible spaces will be able to adapt to a families' needs as the family grows with the house.

A new trend in alterantive building techniques will allow potential homeowners to explore straw, rammed-earth, cordwood, and other housing techinques,while taking advantage of renowable energy sources including, solar, wind and hydro-electric power. Homes will be designed to accomodate household offices, where laptops and Internet accesss become a necessity, instead of novelty. Improved heating and cooling systems and energy-saving appliances will reduce energy consumption by as much as two thirds. Interior surfaces will continue as usual, with new emphasis on natural materials from sustainable resources that are easy to maintain, affordable, and recyclable. New materials will be made from high-tech composites with long life expectancy, and durability. Recycled materials will continue to be used along with synthetic materials in various combinations.

Within the house, daylighting will become more important, while new „smart" windows will turn from clear to opaque for light control and privacy. Windows may also begin to generate electricity through photovoltaic technologies. Curtains, screens, shades, and motors will become integral to a window design allowing windows to be opened, closed, or covered through remote controls and computer automation. Weather sensors on your house will be able to open and close windows depending on weather situations. Window construction will also change as sashes become smalller, locks, handles, and cranks will become integrated with the design, and frames will be made of composite materials.

Changes in lighting will accompany changes in dayligthing and windows. In lighting, fluorescent lighting will go from cool blue to spectrum color, as compact and linear lamps become the norm. New technologies in electronic balasts will allow fluorescents to be switched on by voice command, remote control, or automatically through sensors adjusting light depending on available daylight. Eventually, computers will automatically adjust lighting in rooms as people enter and exit. Indoor lighting will become more energy efficient, while outdoor lighting will depend on solar power. Light bulbs will also become more environmentally friendly, requiring less mercury and other toxic materials.

In the kitchen, safety, comfort and flexibility will be important. Appliances will be more energy-efficient, voice activeted, and adjustable to fit different size users. Computers will hold all recipes, entertain with music and TV, organize personal messages, finances, and „things-to-do".

The bathroom may look the same, but it will be more luxurious, interactive, and practical. Safety and comfort will be worked into the design with aesthetic functionality. Grab bars, non-slip flooring and adjustable lavatories and sinks will blend in with new high-tech conveniences. Ventilation, faucets, and lighting will operate via sensors that will turn on lights as you enter the room, faucets as you place your hands upon them, and ventilation and sanitary automatically as necessary. Water will also be recycled within a homes organic local treatment plant.

Residential Environmental Design Featured Article
www.reddawn.com/featart 11.html

MEGA-FLOAT: AN AIRPORT ISLAND

Japan is a mountainous and densely populated country, two attributes that come into direct conflict when new airport facilities are planned. There simply is not much flat, empty land avaliable for airport developments. Thus, Japanese engineers hava actively pursued alternatives to land-based airports in recent years. Kansai Airport, for example, stands on a reclaimed manmade island off the coast of Osaka. It has been in sevice since 1994.

Where sea depths are too great for reclamation, an obvious, but by no means simple alternative, is to construct a floating island platform-known as a „mega-float"structure upon which an airport can be built. A floating structures present is unaffected by water depths, soil conditions and even earthquakes. With properly engineered systems and services, mega-floats also represent no threat to the ocean environment: indeed, they can even be dismantled or moved to another location if they are no longer needed, or desired, at a particular site. Thus, mega-floats can supplement land reclamation to create offshore infrastructure that is both highly functional and environmentally sound.

Mega-float Airport

The platform covers an area approximately 5000 X 1500 m with a depth of 7 to 10 m to balance local loads of onboard facilities through buoyancy. Cost considerations led to the selection of box-shaped steel pontoons, rather than semi-submersible units. The airport island is moored in relatively calm waters, sheltered by breakwaters if required.

With its vast deck area, a mega-float platform is relatively thin. In response to wave action, the structure behaves as an elastic body; it is not rigid, as is a ship. Much data has been acquired from the 300-m-long test model, including data obtained during a severe typhoon in September 1996 and several medium-sized earthquakes. The three-dimensional elastic behavior of the mega-float platform can now be simulated quite accurately by computer programs dveoloped during the test phase.

Since the platform is floating and made of all steel, the influences of floating behavior, noise and vibration, residual magnetism, and temperature on the operation of the facilities had to be fundamentally investigated. Researchers and technicians were working to draft safety guide and technical standards for assessing the safety of mega-float facilities.

Construction at Sea

A mega-float consists of hundreds of unit modules all joined together at sea to form one huge floating platform suitable for onboard airport facilities. The size of each module is about 300 X 600 m in view of the capacity of shipyard docks.

Assembly

Using ordinary shipbuilding practices, nine units 100 X 20 X 2m were fabricated in various shipyards and towed to the experiment site. There, each unit was drawn by tug boats and winch operations close to the floating model. The units were then joined using jacking devices to cancel mutual motion in the waves and prepared for welding.

Welding

In order to weld in dry conditons on structural members submerged in water, a water evacuation method was developed and its efficacy was confirmed by the tests on the model. Dry spaces were created for welding by pumping or forcing out the sea water under pressure. A movable chamber fitted with a watertight seal was installed on the side walls over the connection between the two units.

Mooring

The mooring system should allow only minimal horizontal displacement when the airport platform is in operation and airplanes approach the floating runway to land. A special mooring mechanism consisting of rubber-coated chains was developed. This system was demonstrated on concrete dolphins to which the mega-float model had been properly moored, and no problems were experienced even when a typhoon passed near the test site.

Long-term Durability

In the aggressive environment of the sea, it si essential to strivre for very high levels of durability for such a costly and important facility. For the full airport facility, highly durable corrosion-resistant materials are applied on the walls expose to sea water in the splash zone. Titanium-clad plates were attached on two separate models and joined together at sea to assure that the construction technology was appropriate for practical use.

Environmental Impact

One of the major challenges associated with the construction and installation of a mega-float is its impact on the ocean environment. In order to develop technology to accurately assess the influence of large floating structurees on their surroundings, tidal flows were monitored near the model and near otehrlarge floating structures, and the state of the marine ecology was continuosly assessed. In this area, too, computer programes were devloped to stimulate ecological behavior. No significant changes in tide flows, water quality or overall ecological health were observed due to the presence of the floating structures.

Eiichi Miwa, Mgr
Structural Engineering International 1/98

BIBLIOGRAPHY

DICTIONARIES:

1. Dictionary of Architecture and Construction, McGraw-Hill Book Company, New York.
2. Hornby, A.S., Oxford Advanced Learner's Dictionary of Current English, 9th Impression, Oxford Universirty Press, Oxford, 1995.
3. Englesko-hrvatski strukovni rječnik Graditeljstvo, Altmedia, d.o.o. Split, 1998.
4. Bujas.Ž., Veliki englesko-hrvatski rječnik, Nakladni zavod Globus, Zagreb, 1999.
5. Čampara E., Međunarodni rječnik arhitekture, građevinarstva i urbanizma, Šahinpašić, Sarajevo, 1998.
6. Aničić,D., Rječnik usklađenog nazivlja u području građevnog konstruktorstva, Građevinski fakultet, Sveučilište J.J. Strossmayera, Osijek, 2001.

BOOKS:

1. Kraljević,L., Sturctures in Time & Space I, Građevinski fakultet, Sveučilište J.J. Strossmayera, Osijek, 2002.
2. Kralčjević,L., Structures in Time & Space II, Građevinski fakultet, Sveučilište J.J. Strossmayera, Osijek, 2002.