Construction and Chemical Technologies

Foundations of Technology (ITEA 20)

Outcomes

In this presentation, you will learn:

- Infrastructure is the underlying bases or basic framework of a system (ITEA 20-J)
- Structures are constructed using a variety of processes and procedures (ITEA 20-K)
- The design of structures includes a number or requirements (ITEA 20-L)
- Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use (ITEA 20-M)
- Structures can include prefabricated materials (ITEA 20-N)

Construction Technologies

Virtually all citizens are affected in one way or another by construction technologies. They purchase and live in homes. They work in offices and factories. They receive radio and telephone signals that have been transmitted through towers. They drive over bridges and park in multi-deck garages.

Structures are everywhere we look no matter what their function. Certain structures should be thought of a much larger system that underlies the functioning of the entire society.

Infrastructure

Roads and bridges, airports and railways, electrical transmission and distribution systems, dams, ships, water-treatment plants, water-supply systems, and sewers all constitute the physical infrastructure of a society. An adequate infrastructure is necessary for other technologies to function efficiently. Infrastructure is the underlying base or basic framework of a system. An infrastructure often includes the basic buildings, services, and installations needed in order for a society or government to function, such as transportation, communication, water, energy, and public information systems.

Types of Buildings

Some of the earliest constructed works were buildings. Buildings are structures providing protection and safety for humans and their possessions. They serve a variety of purposes.

Today, there are at least five different types of buildings:

- **Residential**
- **Commercial**
- **Industrial**
- **Public**
- **Religious**

Ancient ruins in Rome

Residential Buildings

Shelter is one of our basic needs. It protects us from weather and outside threats. Homes make us safer and more comfortable. They contain the basic spaces people need. Most *residential buildings* (homes) have living, food preparation, entertainment, sleeping, storage, and sanitary (bathrooms and laundry) spaces.

Commercial Buildings

Each of us does some business in a building. We buy groceries or clothing in a building. Each of us receives medical or dental care in a building. We may buy an airline ticket at travel agent's office. Any of us may have our car repaired in a garage. We may stay in a motel or hotel as we travel. All these activities are part of commerce. They take place in commercial buildings. The buildings may be professional offices, shopping centers, supermarkets, lodging establishments, or repair facilities. The businesses occupying these buildings provide us with services or sell us goods.

Industrial Structures

All societies produce goods and services they need. They make products in factories. Societies generate electricity in power plants. They develop news and entertainment programs in radio and television studios. These activities are called *industrial* or *productive activities*. They require special structures we call *industrial buildings*.

These structures provide workspace and shelter for people, materials, and equipment. They generally contain office space, production or service areas, storage areas, and worker support areas (such as restrooms, locker areas, and cafeterias).

Public Buildings

People use their tax money to erect special purpose buildings. These buildings are designed to meet public needs. They provide areas for administration, police and security, fire protection, health care, education, and other government functions. Government agencies, such as cities and towns, school districts, states, and the federal government, build them. Most *public buildings* are paid for with tax money. These buildings may be schools, government office buildings, courthouses, jails, and monuments.

School

Courthouse

Religious Buildings

People erect buildings in which they practice their religious activities. *Religious buildings* are called a number of different names. They may be called churches, cathedrals, synagogues, or mosques. These buildings are used for worship, fellowship, education. And other activities associated with religion. In many cases, community service activities are also provided in the buildings. These activities may include counseling, collecting food and clothing for the needy, providing shelter for the homeless. And conducting community interest programs such as music and speakers.

Civil Structures

Civil structures are constructed works supporting the public interest or other technological activities. They are built for the convenience of all the people who live in an area or nation. Civil structures include constructed works that are not buildings.

Examples of civil structures are streets and roads, bridges, tunnels, railroad lines, airport runways, sewers, pipelines, dams, ponds and reservoirs, communication towers, sports fields, monuments, and water towers.

Construction Methods

Construction methods are either on-site or they arepre-fabricated in a factory and then brought to the site and assembled.

On-site construction is when structures are built from various building materials directly at the location where it is to stand. Most large structures are also typically constructed on-site.

Pre-fabricated construction is when components or sections of a structure are manufactured in one location such as a factory setting and then delivered to and assembled on the site. Structures can include prefabricated materials. Certain kinds of materials are appropriate for some prefabricated structures and parts of structures, while others are not. For example, for various reasons, wood, concrete, and steel are commonly used as prefabricated frames for houses, bridges, and buildings. One important quality variable concerns the type and quality of materials used and the support loads required. Prefabricated sections of buildings can be set in place to reduce costs, and a wide range of options are typically available at different costs.

Prefabricated Construction

Pre-fabricated construction is most often employed in the housing industry. The parts are built in a factory and assembled on the site.

Panelized construction is when individual walls panels are assembled on-site with the use of a crane to lift them into place.

Modular construction is the assembly of a structure on-site with sections that were made in a factory. Larger structures such as apartment buildings can also be erected using modular construction.

Inspection

Inspections begin as soon as the foundation construction begins and continue until the structure is completed. The purpose of these inspections is to make sure the structure is being built according to the plans and local building codes are being followed.

Inspections are performed throughout the life of a structure. Periodically structures are checked to make sure they are continuing to perform properly and safely.

Maintenance of Structures

Structures require regular maintenance in order to continue to perform properly. Based on the results of inspections maintenance is recommended or required.

Exterior maintenance would include the repair or replacement of outside elements. Exterior elements could include things like roofing, siding, windows, paint and sidewalks.

Interior maintenance would include the repair or replacement of inside elements. The Interior elements might include walls, floors, and fixtures like lights and sinks.

Systems in a structure must also be repaired or replaced periodically. Systems would include the heating, air conditioning and ventilation (HVAC), electrical and plumbing systems.

Design for Construction

Construction projects are designed systematically through several steps.

- **Determining the purpose and needs for the structure**
- **Determining limitations (location, capital)**
- **Developing several possible designs (sketches)**
- **Evaluating the designs**
- **Choosing a final design**
- **Making working drawings to be used during construction (blue prints)**

Factors in Design

A number of factors are used to guide the process of designing and making structures. Various requirements are used to make construction decisions. Some relate to personal preference, such as location, style, and size.

Other factors deal with legal restrictions, such as zoning laws, building codes, and professional standards. Additionally, the selection of requirements often depend on the kind of structure. For example, a primary consideration for a bridge is strength, whereas style and affordability are important criteria for many homes.

As with other technologies, decisions related to construction have impacts on individuals, society, and the environment. An important purpose of construction is to provide shelter and structures for humans.

Design Principles

Functionalism is the principle that a structure should be designed based on its purpose or function like these railroad bridges.

Structures can be designed based on their appearance or aesthetics.

Usually structures are designed to perform well in terms of both form and function.

Some primary things that need to be considered when designing a structure are:

- **The purpose of the structure**
- **The community**
- **The site (location)**
- **Topographical features (terrain)**
- **The climate**
- **Available capital (funding)**
- **Zoning and codes (legal restrictions)**

Architects and Engineers

Architects are typically involved in designing the form of structures. They create designs that are aesthetically appealing and fit into the environment. Structures are designed by architects and engineers.

Building Codes

Building codes are a set of rules that specify the minimum acceptable level of safety for structures. The main purpose of the building codes is to protect public health, safety and general welfare as they relate to the construction and occupancy of buildings and structures.

The building code becomes a law of a particular jurisdiction when formally enacted by the appropriate authority.

- Building codes are enforced by performing inspections to ensure compliance
- Violations of building codes can lead to fines or even imprisonment
- Violations can also lead to law suits

Requirements and Constraints

The design of structures includes a number of requirements. One of the most important design constraint with structures is function. For example, the function of houses is to provide safe and pleasant shelter for families, whereas the primary function of a bridge is to carry loads over barriers or obstructions.

Other important constraints include appearance, strength, longevity, maintenance, and available utilities. The design and construction of structures is regulated by laws, codes, and professional standards. Common design constraints used by engineers and architects in the design of structures include style, convenience, safety, and efficiency.

Construction Process

Construction is a technological activity. It requires a series of actions that have to be done in the right order. These actions are part of a technical process called the ***construction process***. Construction is the systematic act or process of building, erecting, or construction buildings, roads, or other structures.

Structures are constructed using a variety of processes and procedures. In some cases, the procedure used depends on the type of material available. For example, welds, bolts, and rivets are used to assemble metal framing materials.

Sometimes procedures are selected as a function of cost, skills, and preference of the worker, or the level of quality desired. Citizens should be equipped to evaluate the appropriateness of procedures used.

The construction process generally follows these eight steps:

1. **Preparing to build.**
2. **Preparing the site.**
3. **Setting foundations.**
4. **Building the framework.**
5. **Enclosing the structure.**
6. **Installing utilities.**
7. **Finishing the interior.**
8. **Finishing the site.**

Preparing to Build

A structure starts with an identified need. A family needs a new home. A community needs a new courthouse. A business needs a new store. A doctor needs a new office. The list could go on and on.

The need must be changed into a design. The selection of designs for structures is based on many factors. Builders need to consider style, convenience, cost, climate, and function. They also must pay attention to building laws and codes, which are typically part of the city or county regulations for construction.

Once all of these factors have been considered, a suitable design can be created. The design is described with a set of plans. The new structure is shown on architecture drawings and specifications. The drawings show the shape and size of the proposed structure and the arrangement of spaces within the structure.

They also show the location of features, such as windows and doors, and how foundations , floors, walls, and roofs are to be constructed. Electrical, heating, and plumbing systems are shown. The plans often include additional information sheets called ***specifications***.

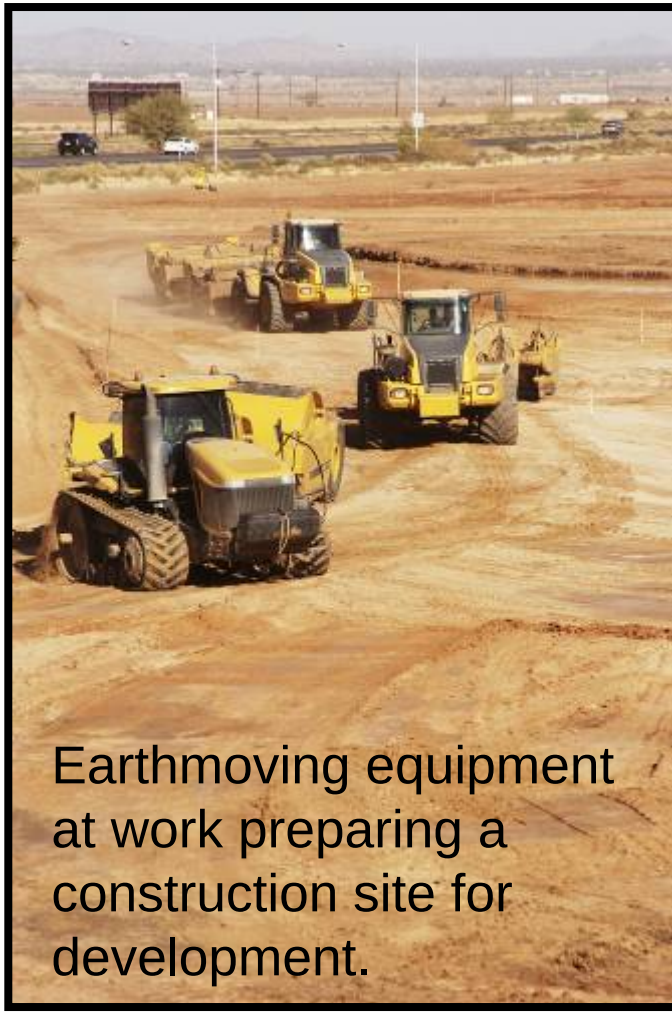
These information sheets are descriptions telling people how the work must be done. They also explain what quality of materials to use. The plans and specifications tell the builder what the structure will look like and how to build it.

Preparing the Site

Few building sites are ready for a new structure. There may be old buildings that must be torn down. Brush and trees may need to be removed. Rocks and debris must be hauled away. The ground may need to be leveled. Sometimes, temporary building and service roads are built to aid the construction of permanent structures.

Once the site is prepared, a structure can be located on it. It must be kept a certain distance from the property of others. Local restrictions dictate these distances. These crews measure distances from the boundary lines of the property. Stakes are driven to show where to place the structure's foundation.

The structure will need to be located on the site. Surveying is done to determine the exact boundaries of the property. The structure is then located on the property.



Earthmoving equipment at work preparing a construction site for development.

Setting Foundations

A constructed structure has two major parts. There is the *substructure* below the ground. It is often called the ***foundation***. The substructure connects the structure to the earth. Also, it spreads out the weight of the structure so the structure does not sink into the ground. The other part of the structure is the ***superstructure***, which is usually seen above the ground. It is the part of the structure that is used. The superstructure is the reason the structure is built.

House foundation – also called the substructure because it will be below the ground once completed.

House superstructure – the structure that is above ground that sits on the foundation.

Building the Framework

Let us explore common frame construction, as it is used in a house. The superstructure of the house is built on top of the foundation. It has three main parts:

- **Floor**
- **Wall**
- **Roof**

Let us explore common frame construction, as it is used in a house. The superstructure of the house is built on top of the foundation. It has three main parts:

Floor

Wall

Roof

Enclosing the Structure

Buildings are designed to serve many purposes such as keeping out the weather (rain, snow, wind, heat, and cold). They protect people and goods as well as provide privacy. To accomplish these tasks, the buildings must be enclosed. Builders will perform many tasks to close in the structure.

They will cover the frame with a sheet materials such as plywood, flake board, oriented strand board (OSB), or insulating board. The material closes the structure and makes the frame more rigid. When this material is applied to outside walls, it is called *sheathing*. Sheathing used on roofs is known as *decking*.

After the sheathing is applied, windows and outside doors are installed. The sheathing, however, is not very attractive. To improve the beauty of the building, attractive waterproof materials cover the sheathing.

There are many different types of exterior building materials. The material may be brick, stone, wood siding, aluminum, vinyl (plastic), brick, veneer, glass, wood panels, rocks, logs, or shingles.

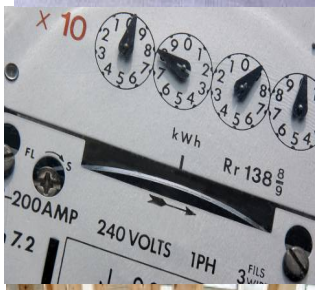
Roofs are more likely to leak than walls are. Special waterproof materials must be used to keep the building dry. Shingles are normally used on all pitched roofs. A shingled roof is installed by attaching many small pieces of waterproof material.

The roofing material must withstand many kinds of weather conditions. As each piece is installed, it overlaps the one beneath it. Shingles are made of many different materials, such as wood, slate, ceramic, aluminum, copper, fiberglass, or asphalt.

Installing Utilities

Buildings usually contain a variety of subsystems, including electrical, water, waste disposal, climate control, communication, and structural subsystems. Most of these subsystems are referred to as utilities. ***Utilities*** are services coming into a building. They are supplied by pipes and cables.

Mechanical systems must be installed before the inside of the house is finished. Installing mechanical systems is called *roughing in*. Usually you cannot see the systems. Mechanical systems are placed inside the walls and under floors. If you go into a basement or under a house, you may see the pipes, ducts, and electrical wiring. The steps in roughing in are usually carried out in a special order. Ductwork or pipes for the heating and cooling system are installed first. They carry warm or cool air from a furnace or air conditioner. These pipes go to each room of the house. They are fitted between the floor joists and wall studs. Plumbing systems are installed next. This system of pipes carries liquids and gases.



Plumbing in a building is needed to accomplish several purposes:

- Provide fresh, pure water
- Remove wastewater
- Carry fuel to furnaces, water heaters, and stoves

Finishing the Interior

Once the utilities are roughed in, the interior can be finished. The walls and ceilings can be insulated. Also, they can be covered with protective and decorating materials. Finally, appliances, cabinets, and fixtures can be installed.

Outside walls and ceilings of the house must be insulated. ***Insulation*** is a material that resists heat passage. It keeps heat inside during cold weather. In hot weather, it keeps the heat outside. Insulation is a very light, soft material made in several forms.

Enclosing Interior Walls and Ceilings: Once the insulation is in the interior can be closed. First, walls and ceilings are covered to provide a smooth surface. This is generally done with drywall or wallboard. Drywallers attach large sheets of drywall with glue or nails. Seams and nail heads are concealed with a special tape and filler.

Finishing includes jobs making the interior of the building attractive. These tasks generally follow a certain order:

1. **Painting and decorating.**
2. **Installing finish flooring.**
3. **Installing window, door, and baseboard trim.**
4. **Installing electrical and plumbing fixtures and accessories.**
5. **Cleaning up.**

Finishing the Interior

Painting and decorating are usually done first. They are done to beautify the interior. Paint protects wood and drywall surfaces. Wallpaper, wood, paneling, and ceramic tile are other choices for wall covering.

Finish *flooring* is usually installed after the painting and decorating are done. Installing it at this point keeps the floors from being damaged during the painting process. Flooring materials are designed to wear well and look attractive. Many different materials make good finish flooring. Wood, carpet, linoleum, and ceramic tile are among the most commonly used.

The final steps involve trimming the structure and installing accessories. Trim consists of the decorative wood or plastic strips covering joints. Joints appear where floors, walls, and ceilings meet. They are also where window and door frames meet walls.

Next, room doors are carefully hung on their hinges. Closet doors are installed. Cabinets are installed in kitchens, bathrooms, and other rooms. These cabinets provide storage space and support countertops. During this installation, the countertops and kitchen appliances are installed.

Finally, hardware and accessories are installed. Hardware includes doorknobs, latches, catches, and brackets. Other accessories include closet shelving and towel bars. Plumbing faucets and electrical fixtures are among the final items installed.

Finishing the Site

Construction is not complete until the building site is finished. During construction, the site becomes cluttered. Scraps of building materials are everywhere. There may be piles of dirt. Several things must still be done:

1. Clearing the site. Clearing the site may need to be done before any other finishing steps are taken. Some of the dirt may not be needed. It must be hauled away. Rocks, trash, and scraps of building materials must be removed.
2. Leveling and grading the ground. Earth may have to be moved. Holes may have been dug for foundations. Some of the earth is pushed back to fill in around the foundation. This is called *backfilling*. The earth is shaped around the structure. Soil may be moved from one spot and placed in another, so it is more pleasing. Topsoil may be returned to areas that have plants and lawn.
3. Creating walks and drives. Walks and drives give users access to a building. Drives must have a heavy base of gravel. The surface may be finer gravel, concrete, or asphalt. Sidewalks can be constructed of concrete, natural stone, wood, or masonry.
4. Adding landscaping. Landscaping is a way of making the site more attractive. It includes planting trees, shrubs, and flowers. Landscaping also often includes planting grass or putting down sod. Ground cover, such as back and rock, is sometimes used where grass is not wanted. It keeps soil from washing away and covers unattractive soil.

Maintenance

We want products and systems to work properly when we need them. This often requires a maintenance program. The goal of ***maintenance*** is to keep products in good condition and in good working order.

Upkeep is a term that is often used in conjunction with or in place of the term *maintenance*. Upkeep refers to all the costs and actions required to keep products and systems operating properly. The next slide shows an example of maintenance or upkeep to windows on a residential building.

Most maintenance is done on a schedule. The schedule is designed to keep the product working properly. Therefore, maintenance is sometimes called ***preventive maintenance***. It is designed to prevent breakdowns.

Maintenance Manuals

Many products come with a maintenance manual. This document lists:

- The types of maintenance needed
- Methods for performing maintenance
- A time schedule for each maintenance task

The information needed to repair a product is contained in the product's service manual. This manual provides a parts list so that repair parts can be ordered. It also gives directions for completing common repairs.

Repair

Constructed structures also need periodic repair. The walls of buildings may crack or be damaged. Roofs begin to leak, or windows get broken. Bridges may need rebuilding. Many streets, highways, and parking areas need patching and resurfacing. These problems are repaired so the building or structure will last longer.

Repair is the process of putting a product back into good working order. This requires three steps:

- ***Diagnosis:*** The cause of the problem is determined.
- ***Replacement*** or ***adjustment***: Worn or broken parts are replaced. Misaligned parts are adjusted.
- ***Testing:*** The repaired product must be tested to ensure that it work properly.

Altering and Restoration

Some products become obsolete as time passes. Their useful life can be extended by *altering* the product. For example, a person may gain or lose weight. His or her clothes may not fit properly. A tailor can alter the clothes to fit the person better.

Buildings are altered also. A building that is outdated can be changed. The needs of the owners may change. The rooms might be too small, or the windows might be too large. Contractors can alter (remodel) the building to meet current needs. Remodeling can involve restoring or changing the appearance of a structure.

Summary

- An important purpose of construction is to provide shelter and structures for humans
- There are at least five different types of buildings or structures: residential, commercial, industrial, public, and religious
- On-site construction is when structures are built from various building materials directly at the location where it is to stand
- Pre-fabricated construction is when components or sections of a structure are manufactured in one location such as a factory setting and then delivered to and assembled on the site
- Inspections make sure a structure is being built according to the plans and local building codes are being followed
- Structures require regular maintenance in order to continue to perform properly
- Architects and engineers are typically involved in designing the form of structures
- Building codes are a set of rules that specify the minimum acceptable level of safety for structures

Summary

- Construction processes include acquiring land, preparing the site, putting in foundations, and building the frame or superstructure
- Construction includes installing mechanical systems and finishing the structure and site
- Construction is the systematic act or process of building, erecting, or construction buildings, roads, or other structures
- One of the most important design constraint with structures is function
- A constructed structure has two major parts: the substructure and the superstructure
- Maintenance means keeping products in good condition and in good working order
- Upkeep refers to all the costs and actions required to keep products and systems operating properly
- Preventive maintenance is designed to prevent breakdowns
- Structures require maintenance, alteration, or renovation periodically to improve them or to alter their intended use
- Most structures are comprised of many systems, each of which commonly requires maintenance
- Remodeling is restoring or changing the appearance of a building or structure
- Altering is to modify or rebuild a product, system, or structure to change or extend its usefulness