

ENGLISH FOR CIVIL ENGINEER

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UNIT 4 MATERIALS

Building materials can be divided into two main groups: natural and man-made. Stone and timber are natural materials, used by man since ancient times. Man-made materials include bricks, cement, concrete, steel, glass, metal and more modern materials including plastic and synthetics.



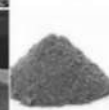
Bricks



Cement



Concrete



Sand



Reinforcement



Glass



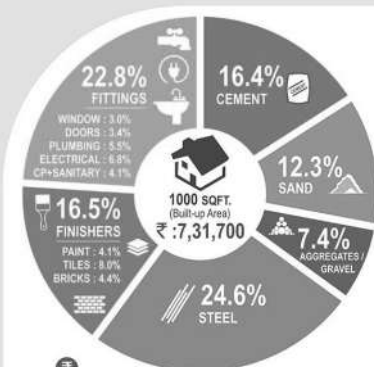
Plastic



Wood



Tiles


Material Quantity

1 SQFT.	1000 SQFT.
0.4 BAG	400 BAG
1.0 CFT.	1000 CFT.
1.35 CFT.	1350 CFT.
4.0 KG.	4000 KG.
0.18 LTR.	180 LTR.
1.45 SQFT.	1450 SQFT.
1.3 SQFT.	1300 SQFT.

**Basic Rate
of Material**

CEMENT	₹ 300	Per Bag
SAND	₹ 50	Per Cft.
GRAVEL	₹ 30	Per Cft.
STEEL	₹ 45	Per Kg.
BRICKS	₹ 7	Per No.
TILES	₹ 45	Per Sq.
PAINT	₹ 250	Per Ltr.


Monthly Cash Outflow For Building Material

- The table on the right top gives material consumption for 1 sq.ft. of built-up area. The material consumption for any house construction can be calculated by multiplying the Total built-up area with the consumption ratio.
- The monthly cash outflow is calculated considering the work duration as 6 months. (From Foundation to Finishing)

Cement

Cement is a material that sets, hardens and can bind together all other building materials.

Sand

Sand is extracted from river bed and is sieved fine. It is then used in preparing concrete mixture.

Stone(Gitti)

Stones (Gitti) are the fillers in concrete mixes. It is offered in 6mm, 12 mm, 20 mm and 40 mm sizes in India.

Wall Putty

Wall Putty is a White Cement based fine powder which provides an ideal finishing for concrete / cement plastered walls and ceilings.

Paint

Paint is used to protect, color, or provide texture to walls and other objects.


TMT Bars

Thermo-Mechanical Treatment is a process to produce high strength steel bars from low carbon steel. They are used to give solid structure.

Binding Wires

Binding wires are used to bind the TMT Steel bars and help in providing proper structure to the construction due to the stability of the TMT Steel Bars.

Brick

Bricks are used for building walls. They come in different shapes, sizes and strength based on different construction requirements.

Cement Block

High strength cement blocks are mainly used for load bearing walls as they have the capacity to withstand the pressure due to the load.

4.1 Traditional material

4.1.1 Stone

Stone walls are one of the oldest construction methods known to mankind. The first stone walls were made laying up stones without any **mortar**. With this method stones are held together by gravity. These walls are usually larger at the base. In Ireland and north-eastern UK counties this kind of wall was made by farmers to create fences. It was quite a long and labour-intensive method, but with no costs. When cement appeared, the first mortared stone walls were created, where cement paste fills the gaps between the stones. The first cements were made using burnt **gypsum** or **lime**, mixed with water.

Concrete includes Portland cement mixed with sand, **gravel** and water, which makes it **resistant** to cracking. To make it even more resistant, steel reinforcing bars can be added. Most stone walls today are made using this method, because it is fast and cheap.



Stonehenge



Giza pyramids



Pantheon



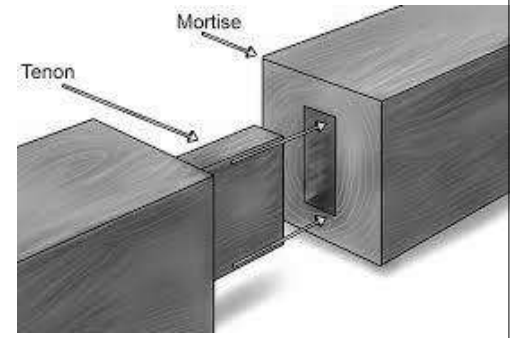
Great wall

Match the two parts of the sentences.

1. The first stone walls were made
 2. When cement appeared
 3. The first cements were created using
 4. Concrete is Portland cement
 5. Steel reinforcing bars can be added
-
- a) burnt gypsum or lime, mixed with water.
 - b) to make concrete even more resistant.
 - c) the first mortared stone walls were created
 - d) without any mortar.
 - e) mix with sand, gravel and water

4.1.2 Timber

Read the text about timber framing and answer the questions below.



Timber framing and conventional wood framing are two different forms of construction. Timber framed structures use fewer, larger timbers with dimensions from 15 to 30 cm and mortise and tenon or wooden pegs as fastening methods, whereas conventional wood-framed buildings have a greater number of timbers with dimensions from 5 to 25 cm, and nails or other mechanical fasteners are used to join the timbers.

Today timber structures are often surrounded in manufactured panels, such as Structural Insulating Panels (SIPs). They are made up of two rigid wooden-based composite materials with a foamed insulating material inside. This method is used because these structures are easier to build and they provide more efficient heat insulation.

Timber-framed construction offers a lot of **advantages**. It is kind to the environment (when the wood used is taken from sustainable forests) and the frames can be put up quickly. Its design is elegant and simple, and also both practical and adaptable. It can give a house character, both inside and outside. Thanks to its strength, large open spaces can be created, something which is not so easy to obtain with other techniques. It is very versatile, so timber-framed houses can also be clad with stone or brick. This offers two more advantages: the house can blend in with the surrounding area (both urban and rural) and it is very energy-efficient. Timber is also cheaper than other materials.

Do timber-framed structures use larger or smaller timbers compared to conventional wood framing?

Which fastening methods do the two different methods use?

What structures have been recently used? How are they made up?

What are the advantages of this method?

Listen to an expert speaking about the disadvantages of timber frame and complete the table.

There are several (1) _____ to timber frame construction but there are also disadvantages that you should be aware of before deciding if it (2) _____ your needs.

Wood is a (3) _____ and very combustible material, susceptible to water, fire and bugs. Water can be (4) _____ into the material, causing it to rot and mould, which can compromise the strength and cause adverse health (5) _____

This can be a (6) _____ problem in humid or damp climates. Wood is also very (7) _____, which makes the material a fire hazard.

(8) _____ and termites eat wood framing, with serious effects on the (9) _____ of the construction.

Logging for timber framing can have a major environmental impact. Producing boards and (10) _____ for timber frame construction requires cutting down trees. Large, old-growth forests are sometimes clear cut to produce wood for timber construction, which can lead to other problems such as soil erosion and destruction of wildlife habitats.

Wood is an excellent (11) _____ of sound waves so any noise inside or outside is easily heard throughout the home.

This can be a major problem if there are several people living in the house or if it is located near a noisy street as sounds are transmitted very clearly. Timber (12) _____ are quite strong up and down but not as strong as other materials (13) _____. So if your building design has a large room with a long span, it will be difficult for timber frame construction to handle the weight. You may need to have a post in the middle to absorb some of the weight.

water	Water can be (1) _____ into the material causing it to rot and mould.
-------	---

fire	Wood is very (2) _____.
------	-------------------------

bugs	Ants and termites eat wood (3) _____.
------	---------------------------------------

environmental impact	Producing boards and beams for timber frame construction requires (4) _____ trees.
----------------------	--

sound	Wood is an excellent (5) _____ of sound waves so any noise inside or outside is easy heard
-------	--

strength	Timber frames are quite strong up and down but not as strong as other materials (6) _____.
----------	--

4.1.3 Brick

Read the text and then write a list of the advantages and disadvantages offered by brick

Masonry construction is a method that has been used for centuries around the world. It is usually used for walls of buildings, retaining walls and monuments. The most frequent type of masonry is brick, but concrete block is also becoming more and more popular. Brick was one of the first building materials that man used and has been used since the times of the ancient Egyptians because it offers a great number of advantages.

First of all, it has an affordable price and it is made of accessible raw material, which has long durability and good insulating properties. It is a strong material and is perfect for load-bearing systems where the loads are compressive. It is the size of a man's hand and therefore simple to use. The appearance of the final work depends on the ability and expertise of the bricklayer.

Another advantage of using brick is that, like stone, it offers increased comfort in the heat of the summer and the cold of the winter. Being heat resistant, this material also offers good fire protection.

One of the disadvantages of using this material is that masonry must be built on a firm foundation to prevent settling and cracking, and in the presence of expansive soils the foundation may need to be elaborate. Moreover, this is a heavy material, consequently the structural requirements will have to be increased, especially if the area is subject to earthquakes.

Advantages	Disadvantages

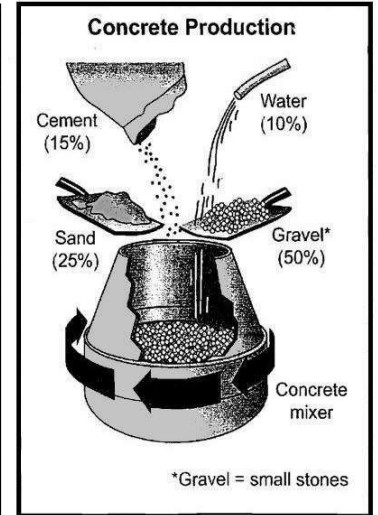
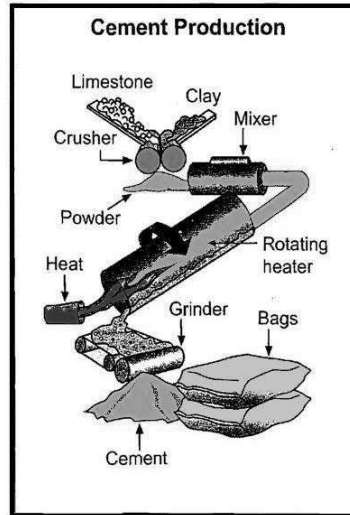
4.1.4 Cement and concrete

Listen and complete the blanks

The most common type of cement is Portland cement, which is the basic (1) _____ of concrete and mortar. It is made of Portland cement clinker (calcium silicates, aluminium and other compounds) and other minor constituents.

Portland cement clinker is produced by heating a mixture of raw (2) _____ up to 1450° C in a kiln.

There are three production stages: preparation of the raw mixture, production of the clinker, preparation of the (3) _____



Limestone is the main raw material for the production of clinker, followed by sand, shale, iron ore, bauxite, fly ash and slag. About 2% **gypsum** is also added and then the (4) is pulverised. The resulting powder will react when water is added.

Portland cement is commonly used to produce (5), which is made of gravel, sand, cement and water. Blocks of cinder concrete, ordinary concrete and hollow tile are known as Concrete Masonry Units (CMU). They are larger than ordinary (6) and used for applications where appearance is not very important, such as in factory walls, garages and industrial buildings.

One of the advantages of concrete (7) is that they can be reinforced, grouting the voids, inserting rebar or using grout, so that they are stronger than typical masonry (8)

Choose the best alternative

- 1 Portland cement is the basic ingredient of *concrete / aluminium*.
- 2 The main raw material for the production of clinker is *brick/limestone*.
- 3 Portland cement is used to produce *gravel/concrete*.
- 4 Concrete Masonry Units are larger than ordinary *bricks/stones*.
- 5 Concrete blocks can be *reinforced/industrial*.
- 6 Reinforced concrete blocks are stronger than masonry *industries/walls*.

Match the words with their definitions

- | | |
|--------------|---|
| 1. masonry | a. a mixture of cement, sand, small stones and water |
| 2. brick | b. brick work |
| 3. concrete | c. white rock often used for making cement |
| 4. mortar | d. a mixture of sand, water and cement or lime |
| 5. limestone | e. a reddish-brown rectangular block used to build walls and houses |

4.2 Modern Building Materials

Steel

Steel is resistant to corrosion, rusting and general deterioration. It can be used both for exterior as well as internal infrastructure. Compared to conventional concrete buildings, steel buildings offer a longer lifetime and they cause less harm to the environment thanks to the **resistance** and **durability**. Because steel buildings are usually **pre-fabricated** or made in sections and parts that are assembled on the construction site, they are cheaper than conventional buildings.

The quantity of carbon contained in steel determines whether the alloy is hard or soft. Nowadays steel buildings are often appreciated for their design. In fact, the flexibility of this material allows different forms and shapes. More than any other building material, steel has a high strength-to-weight ratio. This means that it is easy and cheap to **span** large distances elegantly eliminating columns. Thanks to this, it is easier to subdivide and customise office and warehouse space.

Complete the sentences with words from the text

1. Steel can be used both for the exterior and the interior of a..... building.
2. Steel is.....to corrosion, rusting and general deterioration.
3. Steel buildings have a longer.....compared to conventional concrete buildings.
4. Steel buildings are usually.....than.....buildings.
5. It is easy and cheap to span large.....elegantly.
6. By eliminating....., it is easier to subdivide and customise office and warehouse space.

Match the words to their definitions

- | | |
|------------------|---|
| 1. rusting | a. a composite metal made by mixing other metals together |
| 2. flexibility | b. the period of time for which a building is expected to last |
| 3. alloy | c. when a metal becomes reddish brown because of air and water |
| 4. deterioration | d. to change the appearance or characteristics of something according to someone's taste or needs |
| 5. lifetime | e. becoming worse in quality or condition |
| 6. to customise | f. being bent easily without breaking |

4.3 Concrete work

4.3.1 Overview

1. Read the webpage. Then, choose the correct answers

Our concrete starts with the finest quality cement and water. We then add the cement paste to the right blend and size of aggregate. Our attention to the mixing process ensures that each concrete blend is perfect. It doesn't matter if you're looking for normal-weight concrete, lightweight concrete, insulating concrete or heavyweight concrete. We can provide exactly what you need.

We offer a wide range of fine aggregate and coarse aggregate. They ensure that your concrete **binds** correctly. This way you can custom design the perfect concrete for you and your building project. We even provide air entrainment to most types of concrete. The additional voids it creates help your concrete set perfectly and **prevent** it from **shrinking**. Combined with steel rebars, our concrete can support almost any load.

ABC Cement and Concrete can work with you on-site or deliver pre-mixed batches. We'll meet your needs. So come in to ABC Cement and Concrete for the region's best service and highest quality concrete.

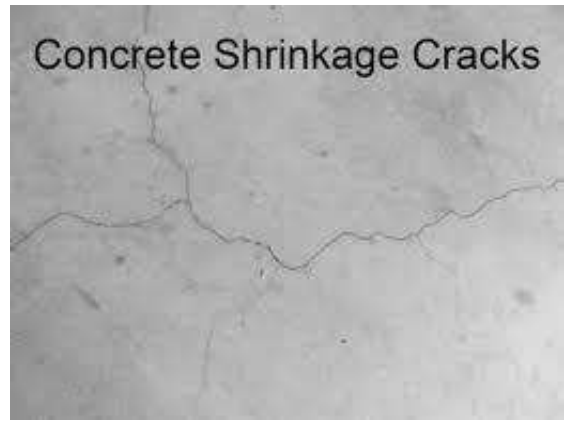
1. What ensures the concrete binds correctly?

- A. air
- B. cement
- C. aggregates
- D. steel rebar

2. Why does the company perform air entrainment?

- A. to ensure proper bonding
- B. to prevent concrete from setting
- C. to decrease the number of voids
- D. to avoid any concrete shrinking

Concrete Shrinkage Cracks



2. Match the words (1-8) with the definitions (A-H).

- | | |
|--------------------|---|
| 1. concrete | A. to attach something to something else |
| 2. shrink | B. the act of mixing small bubbles into concrete |
| 3. aggregate | C. a mixture of cement, water, and aggregate |
| 4. set | D. to become hard and solid |
| 5. void | E. a gap in a substance |
| 6. cement paste | F. a material that helps bind cement |
| 7. bind | G. to become smaller |
| 8. air entrainment | H. the substance formed when water and cement combine |

3. Fill in the blanks with the correct words and phrase

Lightweight concrete, normal-weight concrete, coarse aggregate, insulating concrete, fine aggregate, heavyweight concrete.

- A. _____ should never be used to support a load. It is only used to control temperature
- B. Large stones or chunks of rock are examples of _____
- C. _____ is the densest type of concrete.
- D. Sand is a common _____
- E. _____ is the least dense type of concrete that can still support a load.
- F. _____ is denser than the lightest concrete, but still lighter than the heaviest types of concrete.

4. Listen to a conversation between a contractor and an employee. Mark the following statements as true (T) or false (F).

- 1 _ The man is confused because the concrete won't set
- 2 _ The man thinks heavyweight concrete is the best choice
- 3 _ The woman wants to use sand as an aggregate

Listen again and complete the conversation.

Employee: Excuse me. Ms. Brown. Could I (1) _____ ?

Contractor: Of course, Sam. What's going on? Is there (2) _____ ?

Employee: Well, not really. I'm just a little bit confused about something. I just (3) _____ it with you.

Contractor: Sure. Has the concrete set too slowly again?

Employee: No, no. That's fine. We fixed (4) _____

Contractor: Good. So what's your question?

Employee: It's about the type of concrete we're using. Are we using (5) _____ ?

Contractor: Yes, we are.

Employee: Right. This is a really (6) _____, so shouldn't we use heavyweight concrete?

Contractor: No, lightweight is fine.

Employee: I thought that (7) _____ wasn't strong enough.

Contractor: I see why you are asking. Actually, though, that's not the case.

Employee: It isn't?

Contractor: No. Lightweight concrete is suitable as long as it has (8) _____.

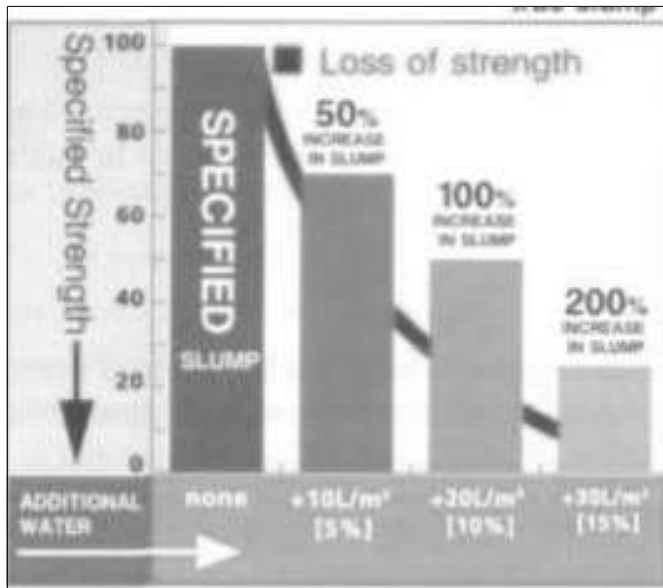
Employee: Oh. So, well use pumice as an aggregate. I assume.

Contractor: No, that's not correct. We need to go with a coarse aggregate, like gravel.

4.3.2 Testing

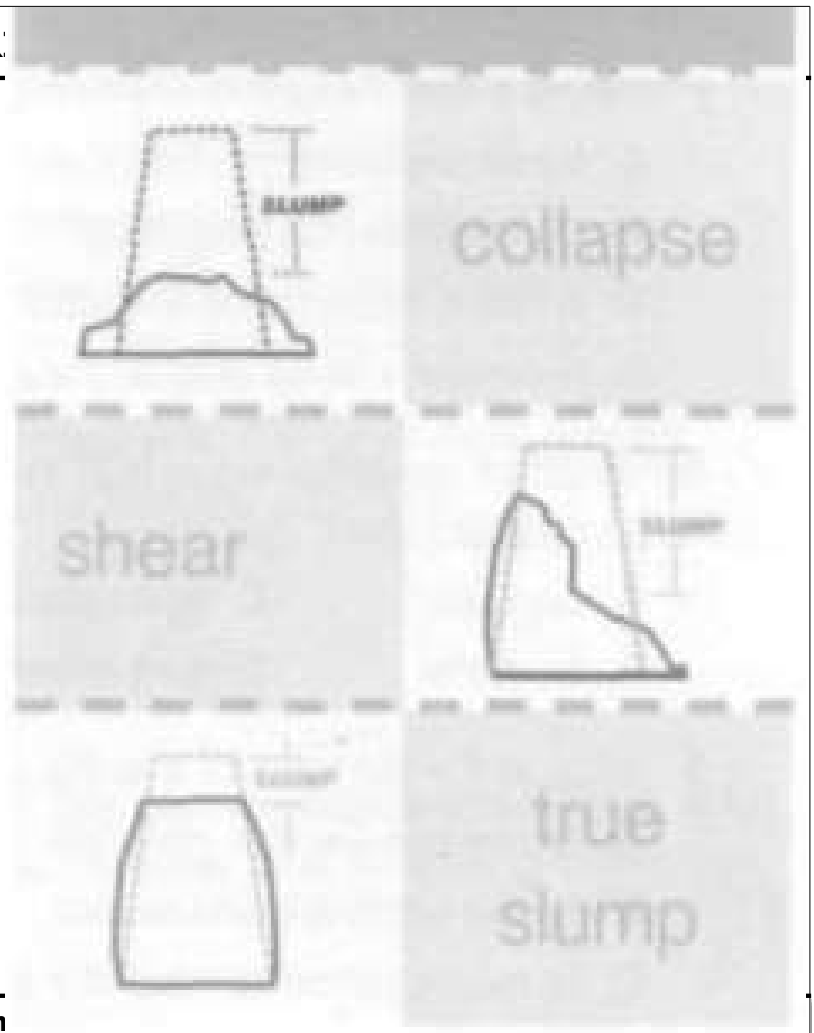
1. Read the website from a concrete testing company. Then, mark the following statements as true (T) or false (F).

Test	What it measures
Soundness	The strength of aggregate used in concrete mixes.
Silt Test	The cleanliness of coarse aggregate. Too much fine material can make the aggregate unusable.
Colorimetric Test	The presence of organic impurities in fine aggregate. Too many make the aggregate unusable.
Gradation	The distribution of particle size in aggregate. A mix of large and small is desirable
Slump Test	The flowability of a concrete mix. A true slump retains its shape when tested while a collapse or shear breaks apart. Such slumps often mean the mix is too wet
Moisture Test	The amount of water in an aggregate. A high amount of moisture may require a lower water: cement ratio to produce a strong mix.
Air Content Test	The amount of air in a concrete mix. Some air is often desired to help concrete flow.
Specific Gravity	The ratio of an aggregate's mass to the mass of an equal volume of water.



water:cement ratio	
m ³	kg
Cement	Water
1 kg/m ³	200 kg

Clay layer- water clears
Silt layers- 2 hours
Sand layers- 1 minute



2. Mark the following statements as true (T) or false (F)

- 1_ A colorimetric test looks for organic impurities in coarse aggregate.
- 2_ Aggregate particles should be about the same size
- 3_ The water cement ratio should decrease when there is a lot of moisture in the aggregate.

3. Match the words (1 - 8) with the definitions (A-H).

1. Silt test
2. Slump test
3. Cleanliness
4. Shear
5. Specific gravity
6. Soundness
7. Colorimetric test
8. Gradation

- A a test to determine the presence of fine organic matter in fine aggregate
- B a kind of concrete slump in which the top portion of the concrete breaks off and slips sideways.
- C a measurement of the strength of an aggregate used in a concrete mix
- D a test to measure how easily a concrete mix flows
- E the distribution of particle sizes in the aggregate used in a concrete mix
- F a test to determine the presence of very fine material in a coarse aggregate
- G the ratio of something's mass to the mass of an equal volume of water
- H a measurement of the presence of silt and other matter sticking to coarse aggregate used in a concrete mix

4. Read the sentence pair. Choose where the words best fit the blanks

1 organic impurity / true slump

A. A colorimetric test will show if there is a(n) _____ in this aggregate

B. A (n) _____ desired for the best **workable** concrete

2 water cement ratio / air content test

A. The _____ showed an acceptable amount of air in this concrete mix.

B. The _____ of this mix needs to be increased.

3 moisture test / collapse

A Please conduct a _____ on this aggregate

B This slump _____ means that the mix is too wet

5. Listen and complete the conversation

Listen to a conversation between a concrete tester and a contractor. Choose the correct answers

1 What is the conversation mainly about?

A. the cause of organic impurities

B. the type of aggregate to use in a mix

C. good and bad results of aggregate tests

D. how to achieve the proper water cement ratio

2 Which test did the aggregate fail?

A. silt test

C. colorimetric test

B. gradation test

D. moisture content test

5. Listen and complete the conversation

Contractor: Good to know. What else?

Tester: It has an **adequate** moisture content. That means we won't have to **adjust** the (1) _____ in the mix

Contractor: Good. Doing that (2) _____ sometimes.

Tester: Right. Now, on to the (3) _____. Unfortunately, the aggregate failed the silt test.

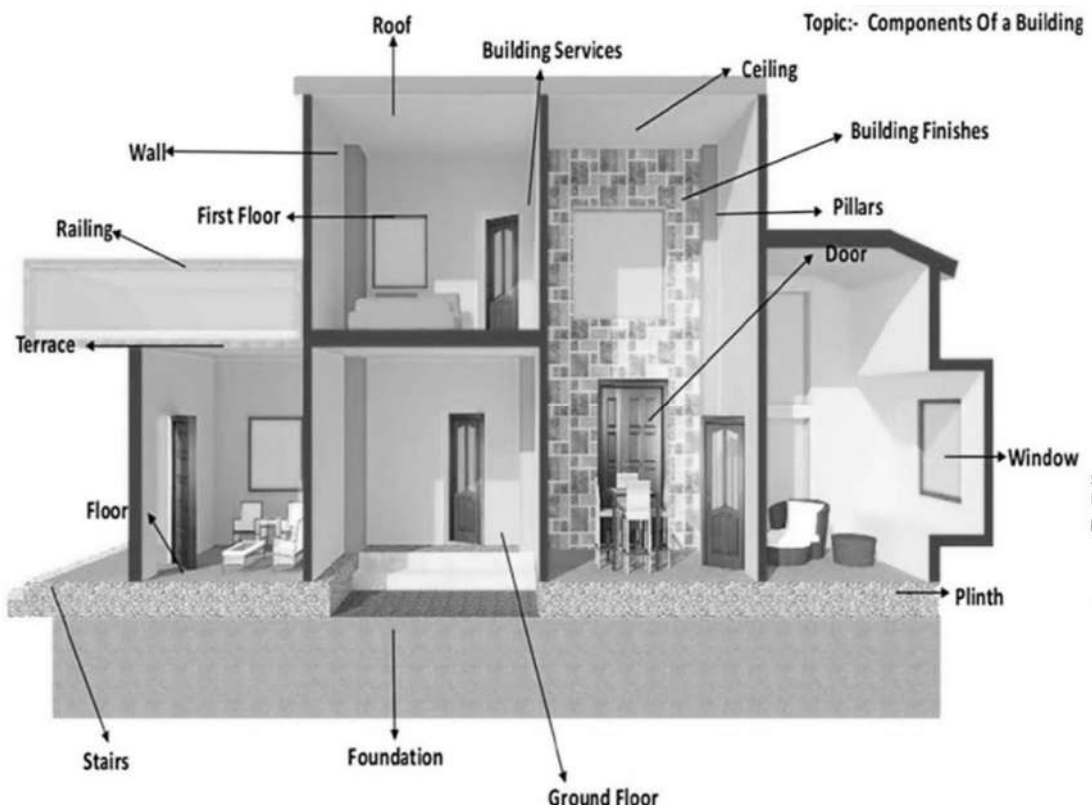
Contractor: (4) _____ what does that mean?

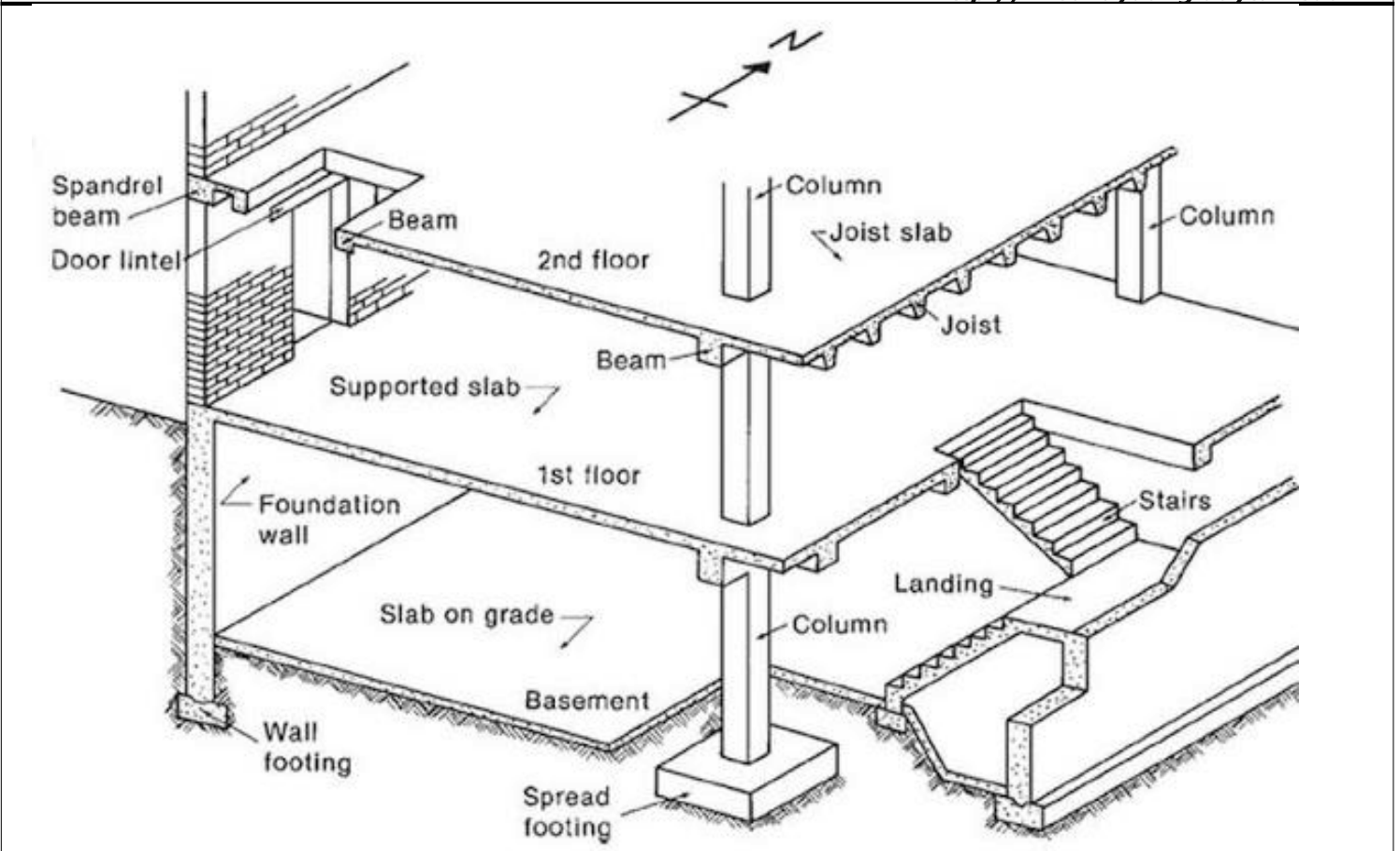
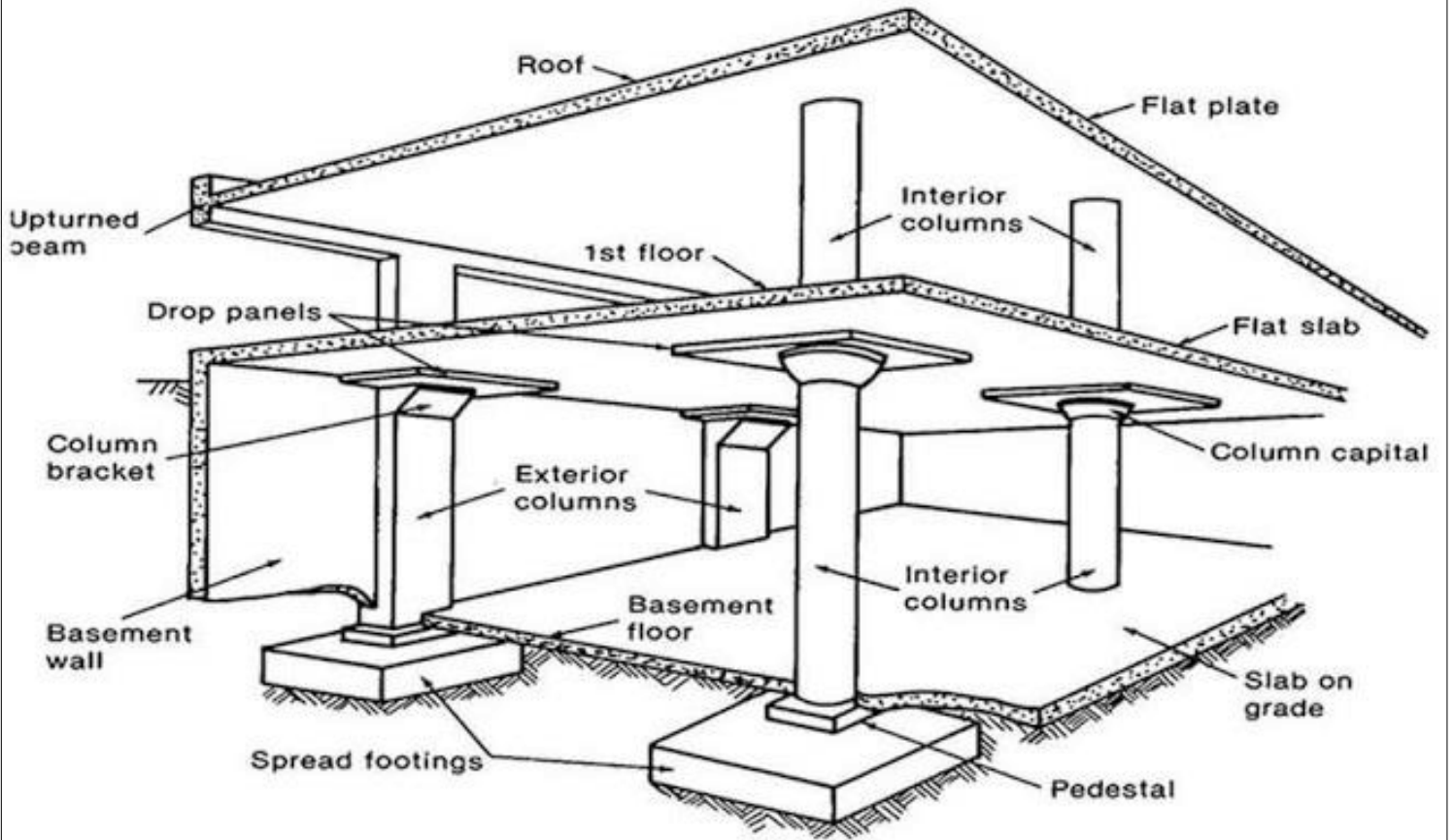
Tester: There's a lot of (5) _____ mixed in with the aggregate. We'd have to use more paste to cover it all.

Contractor: Of course. Is there anything we can do about it?

Tester: We can try to remove some of the material. It should be do-able but it means more (6) _____

The foundations, walls, floor, stairs and roof are some of the building elements that all types of building have in common.





5.1. Foundations

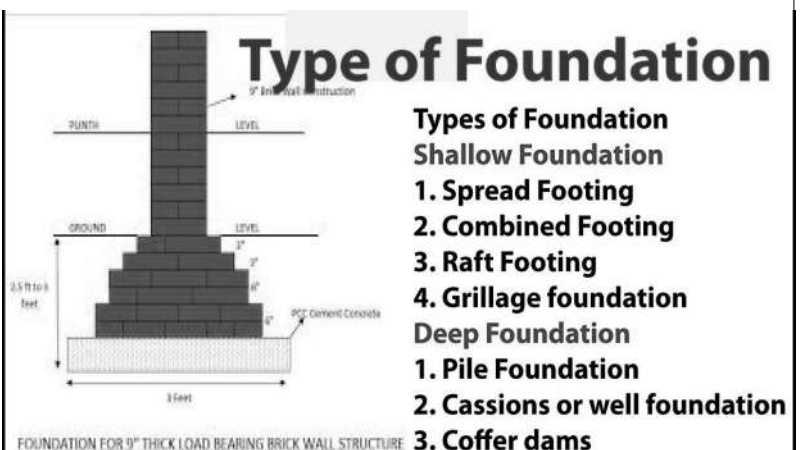
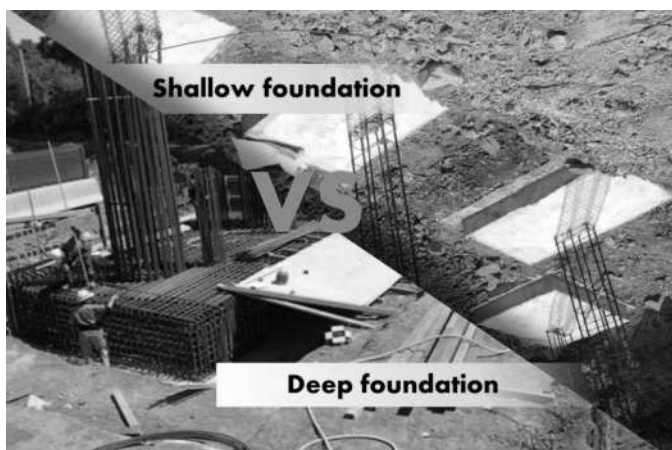
5.1.1 Overview

Read the text and then answer the questions below.

Foundations are structures that transfer weights from walls and columns to the ground. There are two types of foundations: **shallow foundations** and **deep foundations**. Shallow foundations are usually embedded a metre into the soil, whereas deep foundations are embedded more in depth. They are recommended in case of very large design loads, a poor soil at shallow depth or site constraints, such as **property lines**. There are different types of deep foundations and they can be made of timber, steel and reinforced or pretensioned concrete.

Geotechnical engineers design foundations to **ensure** that they have an adequate load capacity with limited **settlement**, when designing foundations, it is also important to consider scour (when flowing water removes supporting soil from around a foundation) and frost heave (when water in the ground freezes and forms ice lenses).

1. What are foundations? How many types of foundations are there?
2. What are the main features of shallow foundations?
3. What are the main features of deep foundations?
4. What do geotechnical engineers design?
5. What must be considered?
6. What are scour and heave?



5.1.2 Types of Foundation

1. Read the website of a home-building company. Then, mark the statements as true (T) or false (F).

The best homes last for generations. It all starts with the foundation. Century Home Builders is known for its sturdy residential structures. CHB specializes in shallow foundations including:

Monolithic foundations

In some areas, a monolithic foundation is the most stable option. The floor slab and the foundation are poured all at once. The foundation extends deeper below load bearing walls to support the building load.

Spread foundations

Century Home Builders provides spread foundations with stem walls. A wide footing is placed two feet below these walls. The stem wall rise above grade to protect structural walls from ground moisture and insects.

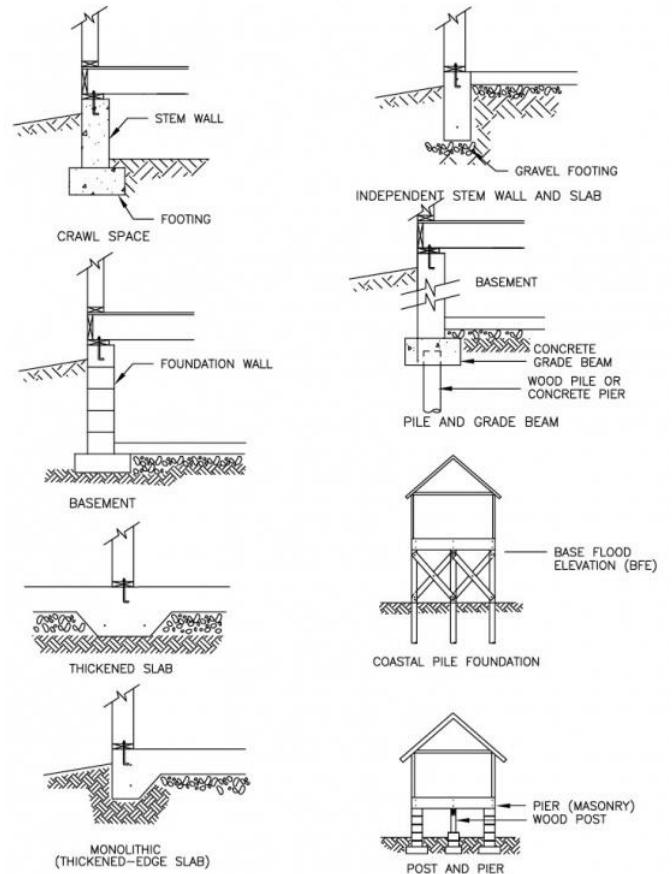
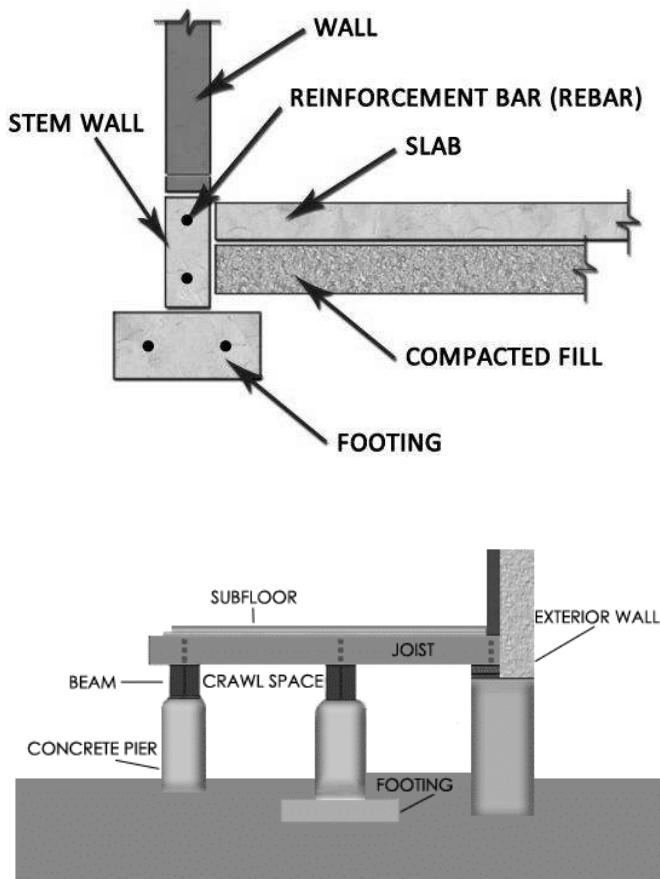
Foundation piers with grade beams

If you live on the coast, you're probably concerned about flooding. In that case, you'd want our foundation **pier** with grade beams. The grade beams support the load bearing walls, but also provide a crawl space below the house. When a flood occurs, it won't fill your first floor!

All CHB homes have our guarantee - they won't **shift**, crack, or settle when the ground freezes and thaws. CHB constructions are built to last!

Mark the statements as true (T) or false (F)

1. _ A monolithic foundation is created in several stages
2. _ Stem walls rest on foundation piers
3. _ Temperature changes in soil can potentially damage a foundation



2. Match the words (1-9) with the definitions (A-I)

- | | | | |
|--------------------------|----------------------|--------------|----------------|
| 1. Footing | 2. Freeze | 3. Pier | 4. Residential |
| 5. Monolithic foundation | 6. Spread foundation | | |
| 7. Shallow foundation | 8. Grade beam | 9. Stem wall | |

- A. a foundation that distributes the weight from walls and columns over an area
- B. a concrete post that sits on piers and support load bearing walls
- C. sections of concrete that he below the foundation
- D. a foundation poured with a floor slab and with deeper parts below load bearing walls
- E. a concrete post formed by pouring concrete into a drilled hole
- F. a structure that rises above grade to which structural walls attach
- G. made up of many homes
- H. to become ice due to cold conditions
- I. a foundation that is constructed close to the surface

5.1.3. Foundations and piles

Read the textbook entry.

Foundations are one of the most essential parts of any building. Builders can use several different types of foundations and piles. The right kind depends on the design of the building and the type of soil.

For very heavy loads, it is best to put in a deep foundation. A drilled foundation with **cast-in-place** piles or a driven foundation with **bearing** piles is often a good choice. Workers use a pile driver to drive the piles into the ground. These deep foundations are suitable when **bedrock** can be reached. **Caissons** may also further support piles in a deep foundation.

If the soil contains more clay, then a friction pile or **friction plus bearing pile** is the best choice. However, horizontal pressure calls for another type of pile. For example, to hold up earth **embankments**, **sheet piles** are ideal.

1. *Mark the statements as true (T) or false (F).*

1. Choosing a foundation depends on the type of soil.
2. Driven foundations cannot be used down to bedrock.
3. A bearing pile is best for soil with a lot of clay.

2. *Match the words (1-6) with the definitions (A-F)*

- | | | |
|------------------------|----------------------|------------------|
| 1. cast-in-place piles | 3. driven foundation | 5. friction pile |
| 2. drilled foundation | 4. caissons | 6. bearing pile |

- A. a box that is filled with concrete.
- B. a type of deep foundation in which piles are pushed into the ground.
- C. a type of deep foundation formed by creating holes in the ground.
- D. a pile that depends on frictional resistance between itself and the material it passes through.
- E. a pile with a large load capacity that transfers the weight of a load vertically.
- F. a pile formed by pouring concrete into a drilled hole.

3. Fill the blanks with correct words and phrases

Piles; pile driver; deep foundation; friction plus bearing pile; sheet piles

- 1 A _____ is used to place piles in the ground.
- 2 A _____ goes all the way to bedrock.
- 3 Use _____ to hold up the embankment.
- 4 Jim ordered some concrete _____ for the new job
- 5 A _____ should be used in soil with lot of clay

5.2. Walls

Read the text and decide if the sentences below are true (T) or false (F). Building walls support the superstructures of building (roofs and ceilings), separate space and give protection against intrusion and the weather. They usually have about three separate components: structural elements, insulation, finish elements or surface.

Walls can be loadbearing or non loadbearing depending on their providing structural support to the building or not. Exterior loadbearing walls carry ceiling, roof or upper floor loads to the foundation. Some bearing walls are inside buildings: they support joists at mid span and transfer loads down to the foundation.

Usually conventional house walls have an inner wooden framework that may support part of the house, but does not support wall coverings, windows and doors. It contains electrical wiring, plumbing, insulation, and other utilities.

5.2. Walls

Read the text and decide if the sentences below are true (T) or false (F).

Walls can define and protect areas, support the superstructures of buildings and delineate a space. _____

There are two kinds of structural walls. _____

Exterior boundary walls give protection against intrusion and weather _____

Loadbearing walls can only be exterior walls. _____

Conventional house walls usually contain electrical wiring or plumbing. _____



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5.3. Floor

Listen and complete the text with the words:

electrical wood surface covering underfloor strength

Floor structure contributes to the general (1) _____ of the building system. It is formed of a steel I-beam **frame** with a horizontal upper (2) _____ to which a number of adjacent composite floor panels is fastened firmly.

Floors consist of a subfloor for support and a floor (3) _____ used to give a good walking surface. In modern buildings the subfloor often has (4) _____ wiring, plumbing, and may provide other services built in, like (5) _____ heating.

There is a wide variety of floor covering materials: carpet, ceramic tiles, (6) _____ flooring, laminated wood or stone.

5.4. Roofs

Read the text and decide if the statements below are true (T) or false (F).

Roofs can be divided in cut roofs, where a carpenter measures, cuts and places every length of wood needed for the frame; and fixed roofs, made of pre-built and assembled trusses. Trusses are custom-designed by computer so as to adapt to the typical weather conditions of the house. As they generally rest only on outside walls, they leave the inside free to move walls and to accommodate different room sizes.

When the frame of the roof is ready, a waterproof membrane is placed over it and it is held in place by battens (long pieces of wood) that are nailed into the truss and are the supporting system for the tiles. Tiles are then nailed to the wood. The top of the roof is finished off with ridge tiles that cover both sides of the roof's top row of tiles. Then the end of the wood at the bottom of the roof is covered by a fascia.

The fascia allows air to flow safely through the membrane. To take away the water from the building, guttering is attached to the fascia. As heat can go straight out of the roof, insulation is also necessary.

When designing the roof structure it must be remembered that all the load on the roof has to be transferred the supporting beams, bearing walls, building foundation and the earth.

1. Trusses are designed to adapt to the typical weather conditions of the house.
2. Battens are long pieces of wood supporting the tiles.
3. The top of the roof is finished off with a waterproof membrane.
4. Then the end of the wood at the bottom of the roof is covered by the guttering.

5.5. Steel frame

There are several important safety concerns when constructing a steel frame. First, ensure that each member is in the correct position. Do so by locating the **erection mark** on each piece. This will tell you how the section shape fits together.

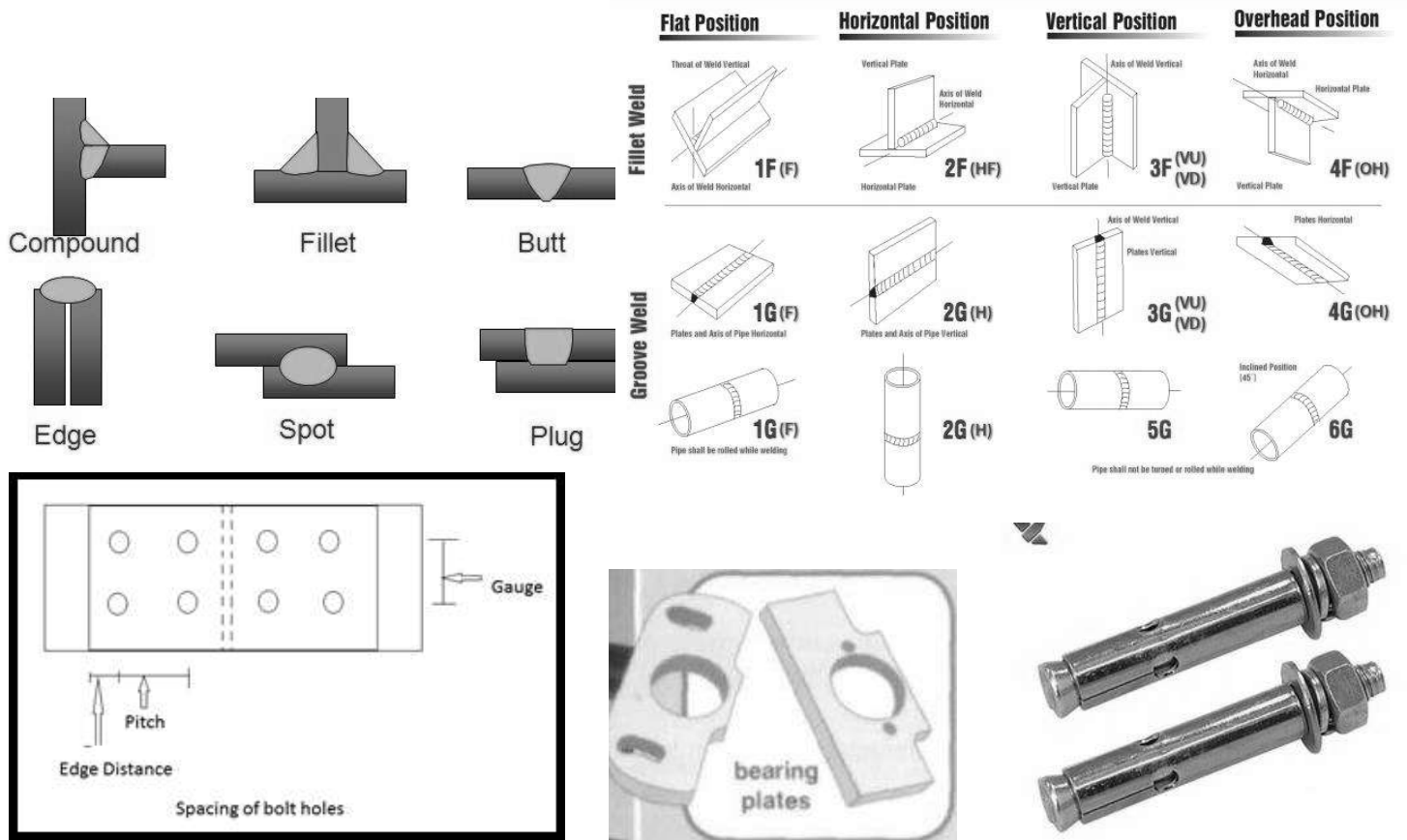
Next, if using a bolting connection, use the correct size and strength of bolt. Bolts are labeled by their ASTM designation. An A307 bolt is not suitable for a job requiring an A325, and vice versa. Also be sure to use the proper type of connection. A **bearing-type connection** should be used where the applied load mainly pulls in one direction. **Friction-type connections** can be used where the load direction varies. When drilling holes, pay attention to the standard pitch and gauge distances for that structural shape.

Welding also has particular connections for specific jobs. Use **fillet welds** as much as possible. They do not require preparation of the welded material. However, a **groove weld** is safer if a very strong connection is needed.

5.5. Steel frame

When erecting a steel frame, place **anchor bolts** carefully. This allows the **bearing plates** to be positioned accurately. These plates will hold the columns of the frame in place, with **girders** connecting between the columns. Last, **open-web steel joists** or bar joists are often used to support roofs and floors.





1. Choose the correct answers

1. What does an erection mark do?
 - A. indicates what kind of connection to use
 - B. shows how a section shape fits together
 - C. shows the strength and size of a bolt
 - D. indicates a pitch and gauge distance
2. When should a bearing-type connection be used?
 - A. when no preparation of the material is needed
 - B. where the load direction varies.
 - C. when a very strong connection is needed
 - D. where the load mainly pulls in one direction
3. Which of the following frame components is placed first?

A. girders	C. anchor bolts
B. Bearing plates	D. columns

2. Fill in the blanks with the correct words and phrases:

**ASTM designation; erection mark; anchor bolt;
friction-type connection; section shape; bearing plate;
bearing-type connection; steel frame.**

1. The wide flange is a common steel frame _____
2. Use a strong _____ to secure the frame to the foundation
3. That bolt has a(n) _____ of A325
4. A building with a(n) _____ can be built many stories high.
5. The bolt transfers the load in a(n) _____
6. Look at the _____ to tell where this piece goes
7. Anchor bolts are fastened into a(n) _____
8. A load is transferred along connected pieces in a _____

3. Match the words (1-9) with the definitions (A-I).

- | | | |
|-----------|--------------------------|------------|
| 1. Girder | 2. groove weld | 3. bolting |
| 4. Pitch | 5. open-web steel joist; | 6. column; |
| 7. gauge | 8. fillet weld | 9. member |

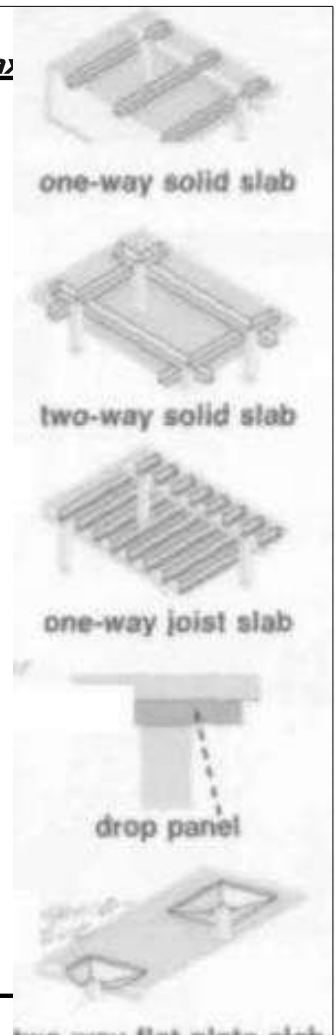
- A. the distance between a row of bolts in a steel frame connection
- B. a type of welding used in steel frame construction that joins pieces of metal that are at 90 degree angles
- C. an individual piece of a structural frame, made of steel, timber, or concrete
- D. the primary horizontal piece of a steel frame
- E. a type of welding used in steel frame construction that does not require preparation on the material that is welded
- F. a lightweight truss used to support a roof or floor in steel frame construction
- G. the distance between the center of holes in a row of bolts in a steel frame connection
- H. the primary vertical piece of a steel frame
- I. the use of strong cylindrical metal fasteners to join pieces of a steel frame

5.6 Concrete floors

Concrete floors are common in both single story buildings and **high-rises**. There are several different methods of arranging the **structural slabs** and support. It is important to be familiar with all types.

A standard **beam-and-slab** floor has concrete slabs supported by concrete beams. Beyond this designs become more complex. A **one-way solid slab** floor has load bearing steel running in the direction of the span. However a **two-way solid slab** floor has load-bearing steel running in two directions. These are supported by concrete columns.

Concrete **drop panels** are located in between the columns and the floor. A similar floor without drop panels is called a **two-way flat plate slab floor**.



Concrete floors

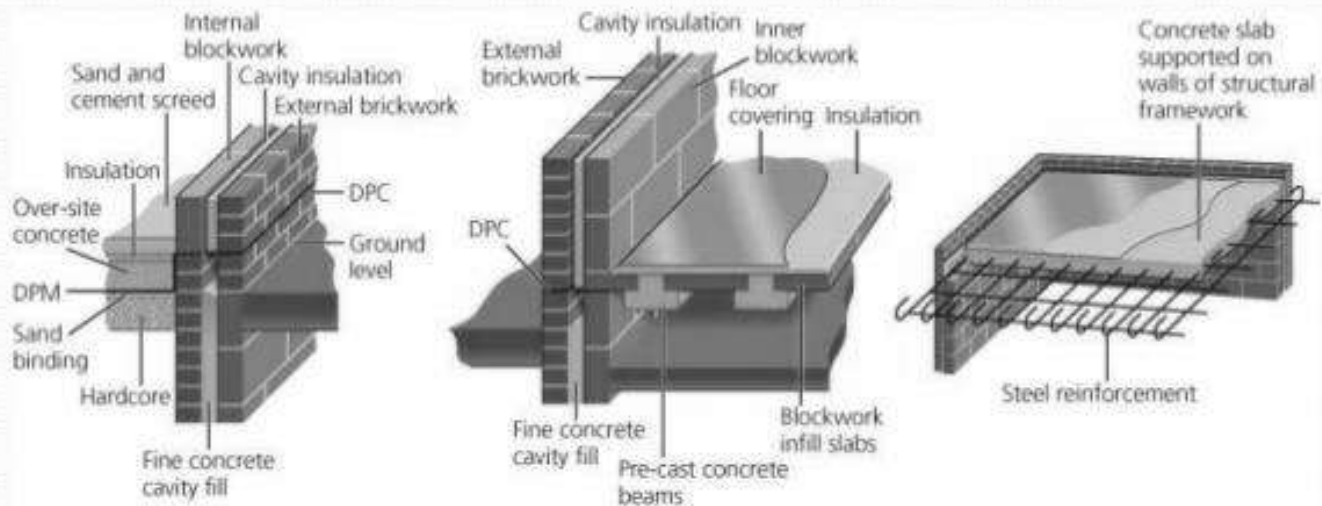
These are well suited for above grade floors. Last, a **one-way joist slab** has a series of horizontal beams that contain reinforcing steel. These may be located at **construction joints**.

There are additional ways to reinforce a concrete floor. Running **tendons** through concrete, and then tightening and **anchoring** them after curing creates a strong **post-tensioned** floor. Also, a **cross-braced** floor with diagonally intersecting supports, has increased **lateral stability**.

1. *Mark the statements as true (T) or false (F)*

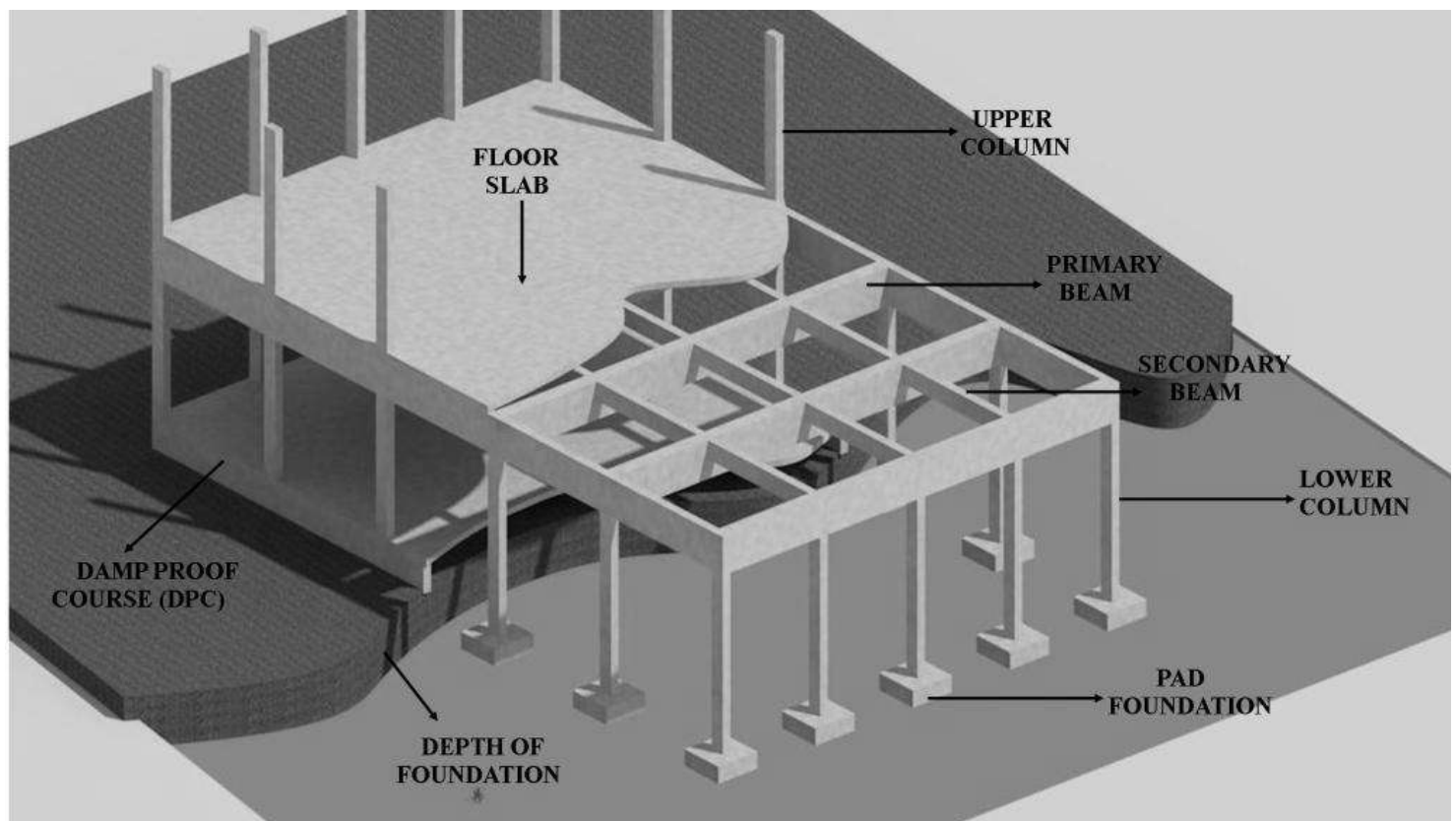
1. Load-bearing steel runs in the direction of the span in a one-way solid slab floor
2. Drop panels are located in between concrete columns and a concrete floor
3. Cross-braced floors are post-tensioned for added strength.

Floor construction (continued)



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2. Match the words (1-9) with the definitions (A-I)

- 1_ two-way solid slab ; 2_ one-way solid slab; 3_ construction joint;
 4_ one-way joist slab; 5_ two-way flat plate slab; 6_ span
 7_ drop panel; 8_ post-tensioned 9_ cross-braced

- A. a concrete surface where the laying of concrete was stopped and later continued
 B. concrete with tension added to it so that it can reach over a longer distance
 C. a structural slab with load-bearing steel running in the direction of the span and steel that controls cracking running perpendicular to the span
 D. the extent of a structure between supports
 E. a structural system that has a series of horizontal concrete beams containing reinforcing steel.
 F. a thickened section of a concrete floor located over a supporting concrete column.
 G. reinforced by diagonally intersecting supports.
 H. a structural slab that has load-bearing steel running in two directions.
 I. a structural slab similar to a two-way solid except that it does not have drop panels.

3. Read the sentence pairs. Choose where the words best fit the blanks

1 *concrete floor / lateral stability*

- A. This building is cross-braced for increased _____
 B. The _____ of this building is reinforced by steel beams.

2 *high-rise / above grade*

- A. This _____ building is over forty stories tall.
 B. The contractor is installing a floor _____ rather than underground.

3 *tendon / beam-and-slab*

- A. A strong _____ has been added to this concrete to give it tension.
 B. This _____ floor is a very common design.