THE **C**ONSTRUCTION**FEEDS**

Rigid spread footings — centric rigid spread footing — eccentric rigid spread footing

Flexible spread footings — centric flexible spread footing — eccentric flexible spread footing

(a) Pad Footing (b) Stepped Footing (c) Sloped Footing

VARIOUS TYPES OF FOOTINGS INCONSTRUCTION

Most of the structures we build stand on some kind of foundations, more commonly, footings. This article discusses various types of footings used in construction.

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Various Types of Footings in Construction

The structures we build today are mostly heavy RCC buildings, requiring solid foundation work to stand upon. This is where footings come in. The structure above the ground is called the superstructure and the solid underground part on which it stands is called the footing. They transfer the vertical and horizontal loads, moments and other forces of the building to the hard soil. Today, we will discuss various types of footings used in construction.

Purpose of Footings

- In order to transfer forces from superstructure to firm soil below.
- In order to distribute stresses evenly on foundation soil such that foundation soil neither fails nor experiences excessive settlement.
- In order to develop an anchor for stability against overturning.
- In order to provide an even surface for smooth construction of superstructure.

There are two main kinds of foundations – deep and shallow. The shallow foundations are generally referred to as footings. Shallow foundations, or footings, are used when the required kind of hard soil is available at a relatively short depth below the ground level, that can support the loads of the superstructure above it.

Types of footings

The different types of footings are as follows:
- Isolated Footing
- Combined footing
- Strap Footing
- Strip Footing
- Mat/Raft Foundation
- Wall footing

Some of the popular types of shallow foundations or footings are discussed below.

1. Isolated footing
This type of footing is provided independently for each column. They are used when SBC is relatively high, the columns are far apart, and there's not much load on the columns. Generally depending upon the shape of the column, the isolated footings may be circular, square, or rectangular in cross-section. However, depending upon the soil condition, you may want to use a different shape.

2. Combined footing
When a footing is provided under a few columns standing close together, it is called a combined column footing. These are used when the columns are too close together to provide separate footings, and if the footings are heavily loaded. Also, if the columns are close to the buildable line, then enough wide footing cannot be provided – so, footings are combined together for interior

and exterior columns. Generally, combined footings are rectangular in size, but you may need to give a trapezoidal footing in case the loads acting on the columns are different.

3. Strap footing
Again, in case where you can't make a complete footing under some of the column of the building, strap footings can be used. It is built by providing a small footing under the affected column, and then extending a strap beam to another complete footing nearby. The strap beam itself doesn't connect to the soil, it just makes sure that the small footing remains there properly.
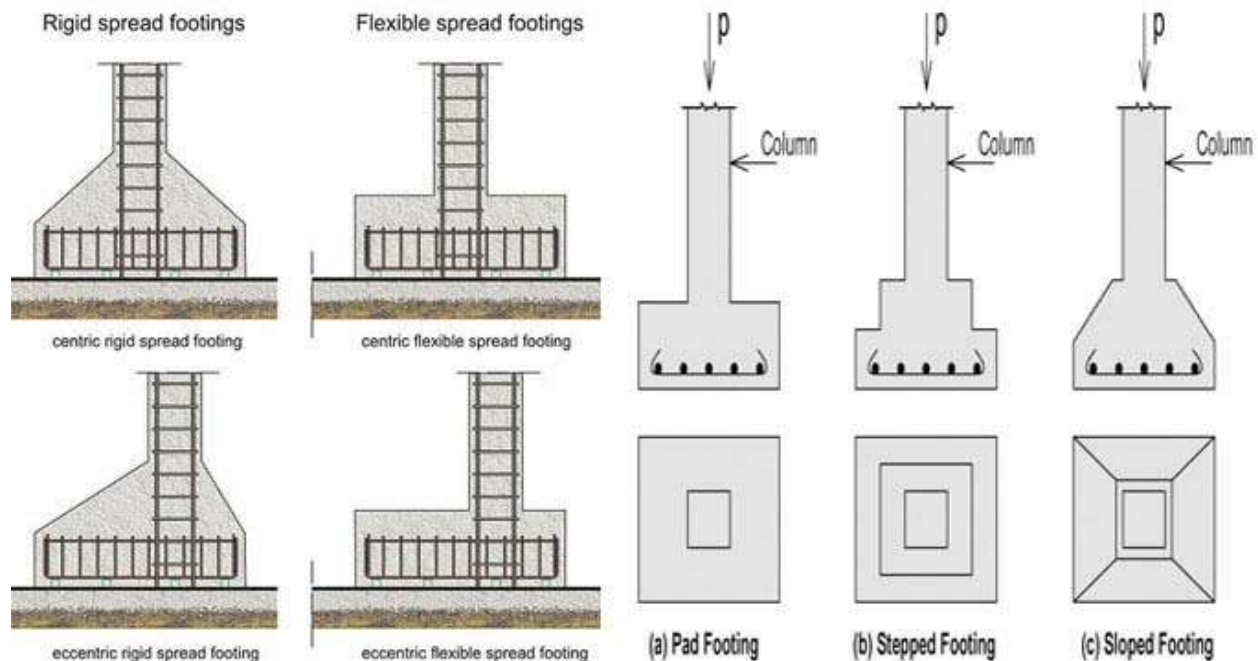
4. Strip footing
When you have a long row of columns standing together and expecting the same loads, then you can use a kind of combined footing called strip footing. It is one thin long slab under the group of columns. It's great for using long corridor-like buildings, or heavy walls, etc.

5. Mat foundation
A mat foundation acts like a hard mat placed under the whole building, hence the name. The mat foundation is a huge slab accepting the loads of ALL the columns in the building. It is especially useful when you have very heavy loads for the building, or the soil may show settlement. Or it may simply be more economic if your columns are quite together and providing isolated footings for each is getting expensive.

Footings are the part of building that directly touches the soil, so everything literally depends upon them. Therefore, you need to be careful in selecting which of the various types of footings in construction you are going to use. A wrong choice may bring disastrous results.

Rigid spread footings | Flexible spread footings

centric rigid spread footing | centric flexible spread footing

eccentric rigid spread footing | eccentric flexible spread footing

(a) Pad Footing | (b) Stepped Footing | (c) Sloped Footing

Why Do We Use Stirrups in Construction

Beams are indispensable in building construction these days, and they take up the whole load of the slab. This produces a lot of tension in the beam. There are two kinds of forces acting, mainly – flexural and shearing. To fight these forces, we use reinforcement bars and stirrups. It's clear why we use rebars – but why do we use stirrups in construction?

Problems of a beam

There are two kinds of steel reinforcements in an RCC beam – longitudinal thick steel bars placed along the length, and bars of smaller diameter looped around the long bars placed at strategic intervals. And the two kinds of failures that may happen in a beam are bending failure due to flexural forces, and shearing failure.

Articles

Under the weight of the floor and wall on top of it, a beam may bend downward, or "sag". This is flexural failure and the longitudinal bars are there to stop this from happening. However, they are not much help when they encounter shearing forces.

When a beam undergoes both shearing and flexural forces, the bar wants to sag or bend downwards. This causes stretching at the bottom of the beam, and compression at the topside of the beam. The stretching at the bottom side will work negatively and try to create cracks there. It happens most at the midsection of the beam, and makes the beam very brittle – thereby compromising the safety of everything being supported by that beam.

The stirrup solution

To prevent this, we may use stirrups. Stirrups resist the shearing action and act as a preventive measure against the long bars getting bent. A similar kind of reinforcement is used in columns as well, but they are called "ties" in that case.

A stirrup is generally a small-diameter steel bar – no. 3 or no. 4 in most cases. It is bent into a rectangular shape to fit snugly around the horizontal bars and hold them in place. They can be "open" or "closed" depending upon how they are tied at the ends – can leave the ends open biasing the protection to one side, or you can make a closed loop of the thin bar to provide all-around protection.

Why do we use stirrups

There is a test of strength for the concrete beams, called uniaxial compression test. In this test, at the end when the stress on a concrete cube reaches the ultimate failure point, vertical cracks appear on the surface and it starts to split up. This happens because the concrete is forced to stretch towards the sides. However, it was observed that if the concrete is "tied up" in lateral directions, then it can't stretch as much and so these cracks will be prevented until much greater loads.

So, there's your reason to provide stirrups. It ties up the concrete in side-to-side, and so the concrete can't stretch and can't break. They can keep this up for a great amount of load. This increases the beam's strength, as well as the final failure strain value.

Stirrups in columns

This idea is excellent when designing bridge columns. As a long, thin structure, a bridge faces a lot of shearing strain, especially in bad weather. Stirrups, or ties as they are called in this case, are provided around the vertical reinforcement bars at regular intervals to fight that force. It also helps to protect the internal core concrete from vertical deformation. This ends up in much stronger columns than one made without ties.

A special stirrup

Open stirrups are the best if you aren't facing much torsional forces at that point of beam. They are great at resisting shear forces. These U-shaped stirrups are placed in such a way that the bottom of the U is at the side of the beam where you're expecting the cracks to appear most.

However, that's not a great idea where you are expecting lots of torsional forces on a point. In such cases, you have to use a closed stirrup to provide protection from all sides.

Aren't RCC beams strong enough already?

To be honest, reinforced cement concrete beams are plenty strong by themselves. They provide some good shear capacity. However, for that to be in effect, the beam has to be quite thick – which

Stirrup

Ties

Beam   ## Column
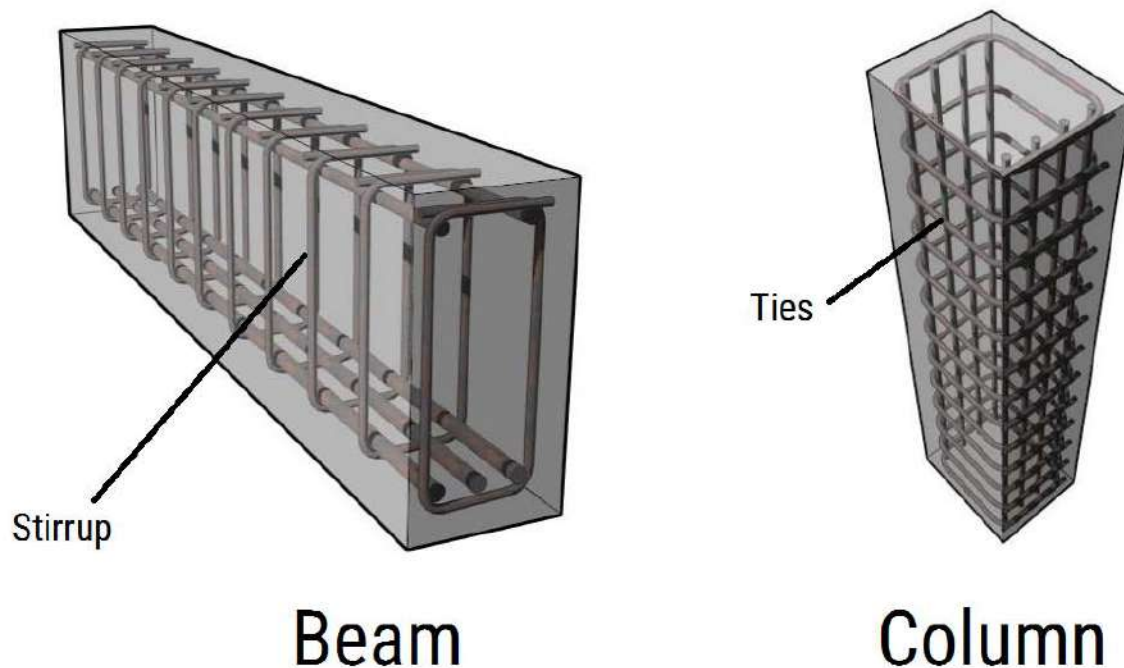
is both ineffective at cost and space economy. If the beam cannot be deep enough to supply enough shear strength by itself – for any reason – then you have to install stirrups to increase the shear capacity of the beam.

When to install stirrups

It isn't a good idea to make stirrups on-site after the bars are already in place. Often this sounds like a good idea since the stirrup is constructed from two pieces with inadequate lap splice. However, it is both easier and efficient to install the stirrup at the same time when the bars are being installed as well.

Classification of Concrete Vibrators for Construction Requirement

For proper compaction of concrete, vibrators play a pivotal role. When the concrete is ready to use, it contains innumerable air bubbles which can deteriorate the concrete structure. The next step is to use concrete vibrators as it eradicates the air bubbles.

During this process one should also keep in mind that over vibration should normally be avoided during the compaction of concrete. If the concrete mix is designed with low workability, over vibration simply consumes extra power of the vibration, resulting in the wastage of energy.

There are different types of concrete vibrators that work on diversified manners. It can be electric or air driven. The vibrators and their functionalities are specified below:

Formwork vibration

A formwork vibrator works with precast concrete. Formwork vibrators are affixed on the outside of concrete formwork, depending on the thickness of the concrete. Formwork vibrators can also be named as shuttering vibrators.As the vibrators are clamped externally on formwork, the inside concrete mass has a direct effect on it.The compaction time or vibrating time in the formwork vibrator is 1mins to 2mins.The formwork vibrator can vibrate at a speed of 9000 cycles per min.

Surface Vibration

Surface vibrators can also be defined as jumpers. Once the concrete mix in poured on the surface, then the vibrators are placed on it. This type of vibrator is beneficial to the slabs having depth up to 10inches or 250mm. Surface vibrators are used for the precast slabs and retaining walls. Surface vibrators can give a very smooth surface concrete.

Internal Vibration

Immersion Concrete vibrator is also called as Internal vibrator. It can also be renamed as Needle vibrator.This vibrator consists of a poker a steel tube with an eccentric element in it, which is closed and rounded at one end. Eccentric elements inside the steel tube cause the vibrations in the concrete.

When using this kind of vibrators, one should always keep in mind to withdraw the device slowly or there will be not enough vibration to expunge the air bubbles formation inside it. These types of vibrators are not to be kept in the concrete for too long, as it could cause the water to separate from the cement, hurting the look and structural integrity of the concrete.

Time duration required for Concrete Vibration

Vibration times will vary depending on the size of vibrator used, the concrete's workability and depth of the concrete member. The concrete vibrating process typically takes between 5 to 15 seconds, if there are still air bubbles in the concrete one needs to remove the vibrator and repeat the process until there are no air bubbles left in the concrete. Contractors must train properly the workers on the proper use of internal vibrators it is important to explain the basic principles of how an internal vibrator works.

Tips for Perfecting Poured concrete

The concrete first needs to be handled and poured well. The first step is to ensure that one must have a proper back up system in place for every part of the job, including extra vibrators and other tools. Avoid bending vibrators and keep in mind not to use vibrators as concrete placement tools.

Usage of Concrete Vibrators

Before initiating the vibration, verification must be properly done that the concrete has not been vibrated previously by any other worker. The vibrator should be let down slowly into poured concrete, allowing the weight of the vibrator to carry it to the bottom of the pour.

Let it sit at the bottom for 10 seconds. Do not turn on the vibrator until the tip is fully immersed. Pull up the vibrator at an average rate of no more than 3 inches per second; often, 1 inch per second yields the best results. Vibrators work different amounts of the poured concrete depending on the strength of the vibrator, which is measured in the circle of concrete affected by the vibration. These circles must overlap so that all the concrete is vibrated properly.

Other Important Guidelines while using a Vibrator

Always hold the vibrator in a vertical position to maximize its effect. Do not force it into the concrete. Concrete sets up in about an hour, and a cold joint is formed between the fresh concrete and the more hardened concrete, weakening the overall structure. Vibration every 15 minutes can prevent concrete from setting as quickly so that concrete bonds together until fresh concrete can be obtained to continue the pour.

Don't under vibrate low slump concrete. Creating concrete with a low slump makes it more difficult to work and require more vibration. For small scale jobs use lightweight portable vibrators.

Comparative Analysis of Slab to Beam Load Transfer

Load transfer mechanism in reinforced cement concrete (RCC) structures is a truly intriguing matter. The loads of a floor fall totally on the floor slab. They are transferred to the beams, then to the columns, and finally to foundation. Today, we will do a comparative analysis of slab to beam load transfer.

The forces acting on a slab are expressed as slab pressure loads, which are told in terms of kN/m^2. However, when these loads are transferred to the beams supporting the slab, they morph into what we call line loads on beams, given in kN/m. This transfer has to be uniform on all sides (unless you have designed it specially for skewed loads) or else the flooring may crack, or worse.

Editorials

Reynolds and Steedman (2005) present some very useful formulas to represent uniformly distributed slab loads transferred to beams. These formulae are great for analyzing the load transfer system from a two-way or one-way slab to its supporting beam.

The formulas are as follows:
- **One-way slab** ($l_y/l_x > 2$)
    - Long span: $p = nl_x/2$
    - Short span: $p = nl_x/5$
- **Two-way slab** ($l_y/l_x < 2$)
    - Long span: $p = nl_x/2(1 - 1/3k^2)$
    - Short span: $p = nl_x/3$
- Where,
    - n = load from slab
    - l_y = length of long side of the slab
    - l_x = length of short side pf the slab
    - k = aspect ratio = l_y/l_x

We can take three different approaches to do a comparative analysis of slab to beam load transfer. These are:
1. Finite element analysis using Staad Pro
2. Yield line method using Staad Pro
3. Manual calculation using formulas

Now let us look at each method one by one, each once for a one-way slab and a two way slab.

One-way slab
Data given:
- Slab dimension: 2.5 m x 7 m
- Supported by beams on all 4 sides
- Pressure load = $10 \, kN/m^2$

Therefore,

Aspect ratio, k
- $= l_y/l_x$
- $= 7/2.5$
- **= 2.8**

1. Calculation using finite element analysis using Staad Pro
Long span beam
- Maximum span moment
= **60.689 kNm**
- Support moment = **-6.337 kNm**
- End shear = **29.7 kN**

Short span beam:
- Maximum span moment
= **12.091 kNm**
- Support moment = **+2.81 kNm**
- End shear = **11.6 kN**

2. Yield line method using Staad Pro
Long span beam:
- Maximum span moment = **63.4 kNm**
- Support moment = **-9.9 kNm**
- End shear = **35.9 kN**

Short span beam:
- Maximum span moment = **6.16 kNm**
- Support moment = **-0.346 kNm**
- End shear = **7.81 kN**

3. Manual analysis using formulae
Load on long span beam
- $= nl_x/2$
- $= (10 \times 2.5)/2$
- **= 12.5 kN/m**
- Maximum span moment
  - $= ql^2/8$
  - $= (12.5 \times 7^2)/8$
  - **= 76.56 kNm**
- End shear
  - $= ql/2$
  - $= (12.5 \times 7)/2$
  - **= 43.75 kN**

Load on the short span beam
- $= nl_x/5$
- $= (10 \times 2.5)/5$
- **= 5 kN/m**
- Maximum span moment
  - $= ql^2/8$
  - $= (5 \times 2.5^2)/8$
  - **= 3.906 kNm**
- End shear
  - $= ql/2$
  - $= (5 \times 2.5)/2$
  - **= 6.25 kN**

So, we can see that in the one-way slab system, in the longer side, the finite element analysis and yield line analysis methods give quite similar results. But our manual calculation has overestimated the bending moment and shear forces.

In the short span direction, both the yield line method and manual method underestimates the loads transferred. However, the manual calculation gives quite good results for bending moments that can be used for design.

Two-way slab
Data given:
- Slab dimension: 5 m x 6 m
- Supported by beams on all 4 sides
- Pressure load = 10 kN/m^2

Therefore,
Aspect ratio, k
- $= l_y/l_x$
- $= 6/5$
- **= 1.2**

1. Calculation using finite element analysis using Staad Pro
Long span beam
- Maximum span moment
= **73.063 kNm**
- Support moment = **-2.71 kNm**
- End shear = **37.6 kN**

Short span beam:
- Maximum span moment
= **54.495 kNm**
- Support moment = **-0.814 kNm**
- End shear = **31.9 kN**

2. Yield line method using Staad Pro
Long span beam:
- Maximum span moment
= **76.562 kNm**
- Support moment = **-9.897 kNm**
- End shear = **39.4 kN**

Short span beam:
- Maximum span moment
= **46.987 kNm**
- Support moment = **-5.096kNm**
- End shear = **30.151 kN**

3. Manual analysis using formulae
Load on long span beam
- $= nl_x/2(1 - 1/3k^2)$
- $= [(10 \times 5)/2] \times [1 - 1/(3 \times 1.2^2)]$
- = **19.212 kN/m**
- Maximum span moment
  - $= ql^2/8$
  - $= (19.212 \times 6^2)/8$
  - = **86.454 kNm**
- End shear
  - $= ql/2$
  - $= (19.212 \times 6)/2$
  - = **57.636 kN**

Load on the short span beam
- $= nl_x/3$
- $= (10 \times 5)/3$
- = **16.667 kN/m**
- Maximum span moment
  - $= ql^2/8$
  - $= (16.667 \times 5^2)/8$
  - = **52.084 kNm**
- End shear
  - $= ql/2$
  - $= (16.667 \times 5)/2$
  - = **41.6675 kN**

Now, in the case of two-way slabs, our observations are obviously not much different. The bending moment and shear forces are quite similar in automated Staad Pro methods (1 and 2). Again, manual analysis overestimates the slab loads transferred to the beam in the long span.
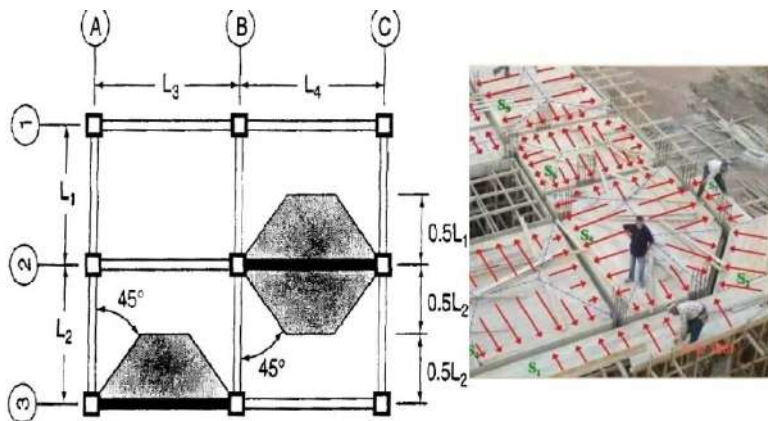
Whereas in the short span, yield line method falls short of expectation but manual method gave came very close to the automated finite element analysis. This is a dependable result and thus can be used in design. However, the sagging moment in the long span needs to be redistributed by 10%.

Contrasting Speculation of Development Length and Lap Length

The main purpose of providing reinforcement bars is to transfer the load from member to member.it may be either to another reinforcement bar or to concrete. In Order to successfully transfer the load from one member to another, reinforcement bars need to be firmly tied at both ends so that it can't be slipped away.

Tips & Tricks

Description of two important terms used in reinforcement binding is prescribed below:

Development Length:

It is a length of Steel bar needed to be embedded into the column to establish the desired Bond strength between concrete and Steel. In simple language it is the length of Steel bar which holds to concrete members together. Concrete members like beams, columns, footings etc.

It is a grip between steel and concrete and makes a continuous structure. It is also known as anchorage length. It transfers stresses from steel bar to concrete and makes a continuous structure. It is provided as a bend. Such length is provided in a column footing joint, column beam joint and other critical joints. Reinforcement bars is bent because there is no space available at the end section.

Provision of appropriate development is an important aspect of safe construction practices, proper development length in reinforced bars shall be provided as per the steel grade considered in design.

Development Length Example

Here is a classic example of typical Beam-column connection.
Reinforcement in the beam is extended into the column for some distance.
{math}(L_d+10 d_a){/math}
L_d= Development Length in Tension
d_b= Bar Diameter

Calculated tension or compression reinforcement at each section of a R-C member is developed on each side of that section by hooks or embedded length or mechanical devices. If the restraining concrete section is comparatively thin it cannot withheld the position of highly stressed bars then development is provided. Thus, to avoid splitting of bars from concrete. This extra embedment length provided is called as development length.

Basic purpose is to provide fixed support to the bars. Hooks are not provided in compression reinforcement. Where there is no space for extra length, hooks are provided for restraints.

Lap Length

As the name suggest, lap length is provided for overlapping two rebars in order to safely transfer the load from one bar to another bar. We know that rebars come in a certain length. If the rebar needs to be extended beyond that limit then sufficient lap length to be provided to safely transfer

the load. Lapping length required to safely transfer stress from one bar to another. It varies from member to member and depends upon the grade of concrete, bar size, concrete cover etc.

In the case of bars having different diameter are to be spliced the length is calculated on the basis of the smaller diameter of the bar. Lapping splice should not be used for the bars having a larger diameter than 36 mm. In that case, welding should be done. But if welding is not practicable then lapping may be permitted for the bars larger than 36 mm diameter. The additional spiral should be provided around the lapped bar.

In India, the requirement of reinforcement bar splicing is covered in IS456 cl.25.2.5.
The code also specifies that the splicing of flexural members should not be at sections where the bending moment is more than 50% of the moment of resistance, and not more than 50% of reinforcement bars should be spliced at any given section.

Difference Between Development Length & Lap Length
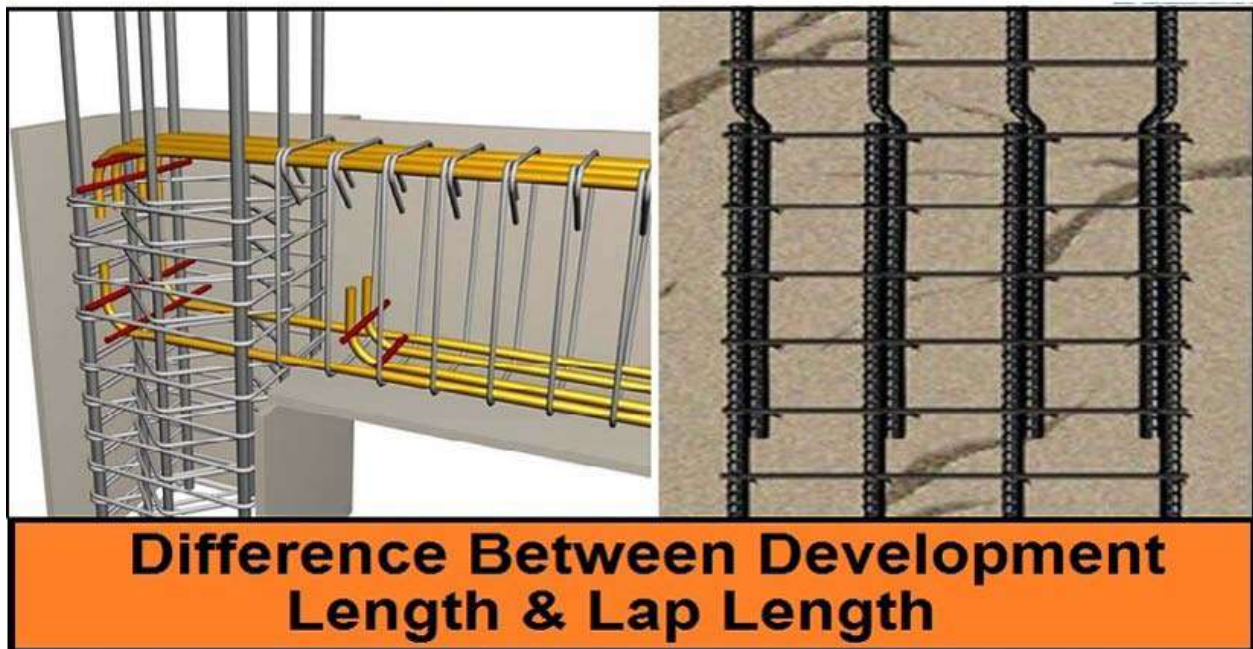
What is Concrete Slump Test and How is it Done

What is the Concrete Slump Test?
When you need to quickly measure the workability or fluidity of the concrete mix on site, the best test available is the concrete slump test. This is the best indirect method available to us to test a concrete mix on-site.

A slump test basically determines the consistency or the stiffness of a paste-type mix. When performed on concrete mix, it tells us how much water has been used to make that concrete mix and whether it can be in the given situation or not.

The concrete slump test is very popular for two reasons. One, it is a great method to make sure the consistency of concrete remains the same between batches. Two, it is a very simple test requiring very little in the manner of equipment and training.

Principles of the Concrete Slump Test
A concrete slump test is an empirical testing procedure to determine the workability of a fresh concrete mix. It is used to find out the properties of fresh concrete and lets one understand if the quality of the concrete is the same as the required concrete properties.

The test, in principle, is all about measuring the behavior of concrete when subjected freely to gravity. The concrete is compacted into a conical shape, inverted, and laid to rest on a flat surface. Under the pull of gravity, the concrete slumps downwards to some extent, as all fluids do. Measuring the amount of the slump, that is, the deviation of height between the cone and the sat-down shape, is the direct indicator of the concrete's consistency. Which, in turn, indicates the workability of the concrete.

Equipment required for a slump test
1. Slump cone (12" x 8"/4")
2. Measuring scale/ruler
3. Temping rod, made of steel

Slump test procedure
a. You need to use a frustum of a cone, measuring 300 mm in height, and 200 mm at bottom sloping to a 100 mm hole at the top.
b. This container is places on a smooth surface at room temperature. Then it is filled with a fresh concrete mix, in three equal layers.
c. When pouring each layer, it is temped 25 times with the temping rod. The rod should have a rounded end and be no more than 16 mm in width.
d. When all of the cone is filled, level off the top of the cone by using the temping rod, gently.
e. Make sure the mold was held firmly to the base as to not allow any movements.
f. When the mix is cleaned off the top, slowly and gently lift off the cone in a clear vertical. The concrete beneath will now slump due to the pull of gravity, because it has no outer wall to support it anymore.

g. Measure the decrease in the height. Do it by placing the cone right beside the slumped concrete and using the temping rod to mark the height difference. Generally, this difference is rounded off to the nearest 5th millimeter.

Precautions to be taken in the concrete slump test

1. Concrete has some friction and may stick to the inside of the cone. For this reason, wet the inside of the cone before performing the test.
2. Make sure the cone is clean of any dry concrete residue from before.
3. Clean the base surface before the test as well, and make sure there are no concrete left around the base of the cone before lifting it off.

Interpreting the slump test results

- Slump **0-25 mm**: **very low workability**, good for road construction.
- Slump **25-50 mm**: l**ow workability**, good for light foundations.
- Slump **50-100 mm**: **medium workability**, good for flat slabs and heavy reinforcements (with vibration).
- Slump **100-175 mm**: **high workability**, good for highly congested reinforced concrete. Should never be vibrated.

Keep in mind that dry samples and wet samples will produce different slump test results for the same ratio of mix. Also, temperature and humidity have noticeable effects on the slump values. Not to mention the weight and the size of the aggregate used in the concrete mix, and how well the concrete was mixed, all of these will factor in the slump test values.

Prevention & Remedies of Honeycombs in Concrete

Concrete is the most useful building material ever, but it has its downsides. One of the problems with concrete is the frequent corrosion issues it faces. Also, if the concrete is not applied properly, it may have problems One such problem is honeycombs in concrete, which are very damaging to the structure indeed. Today, we will discuss about the causes, prevention and remedies of honeycombs in concrete.

What does honeycomb in concrete look like

Honeycombs in concrete are a fashionable name given to a certain type of damages appearing on the surface of a concrete structure. You may see some pits on the concrete surface, empty areas, that look like as if the concrete has been gauged out of the surface. Sometimes, you may be able to see the reinforcements within. This is called honeycombs in concrete.

An extremely serious matters, honeycombs can be very damaging to the concrete. Obviously, it reduces the strength of the concrete. But not only that, if the reinforcement gets exposed due to the honeycombing, it will be unprotected from weathering effects such as oxidization and rusting. This will severely weaken or may even break the RCC member with the honeycombs.

Not only that. Honeycombs are often more than what they look – there are gaps under the honeycombs, air bubbles joined by microscopic tunnels. Water and moisture can get through this way into the concrete, and then corrode it from the inside.

For those reasons, concrete honeycombs must be taken very seriously and be treated at once they are found.

Why do honeycombs occur in concrete?

There are many reasons why honeycombs may occur in concrete. Some of the major reasons of concrete honeycombing are:

1. Wrong workability: If the concrete was stiffer or harder than it was needed for the forces applied on that member, then the application process itself will be difficult. This will, in turn, cause honeycombs later.
2. Extra water in the mix: Quite the opposite of the above is also possible. If you have added too much water, the aggregate may fall off the concrete mix when applied, leaving honeycombs.
3. Improper vibration: If you apply too much vibration to the concrete, or if you don't take care what you're hitting while vibrating, then the concrete might leak through the formwork. In turn, that will leave room for the concrete to settle, and honeycombs will appear on surface.
4. Too much height: if the concrete mix is fluid enough, don't apply it to build tall members. Because due to the gravitational pull, the aggregate may get separated from the rest and settle below, and then you'll not only have to work with an improper mix but also honeycombs at the higher side.

5. Reinforcement lapping: When you are building joints like beam to beam or column to column, the reinforcements overlap. This dense jungle of reinforcement is difficult for the concrete to get into, and so air gaps remain inside the joints. It doesn't only weaken the joint but also later causes honeycombs.

6. Improper aggregate ratio: If you are using too much coarse aggregates (>20mm) then they will make it difficult for the fine aggregate (10mm) to get through them inside the formwork. This will, like above, leave air gaps in the concrete and cause later settlement, causing honeycombs.

How do we prevent honeycombs from happening?

a. Listen to the designer. The designer knows where what kind of concrete is needed, and deviating from that precise need is always dangerous.

b. No-risk construction. Do not take any chances while making load-bearing members of the structure. Columns and beams especially vulnerable to this matter, and so you should take utmost care that none of the issues described above may occur while building them.

c. Use fine aggregates at joints. Even if the designer didn't explicitly mention, you should use a mix with only small chips (less than 20mm) at the beam/column joints, and carefully vibrate. This should make sure the mix gets everywhere it needs to be and there are no places to settle.

d. Tap the wood. While concreting, tap the outside of the formwork with wooden hammers or similar tools. This Makes sure the surface concrete is free of bubbles and greatly reduces honeycombing risk.

e. Micro-vibrate. Use a 25mm or lesser needle for vibrating inside the reinforcement overlap points, to make sure they get the concrete inside the cages.

What to do when honeycombs appear on concrete

First, judge how severe they are. Depending upon their location or type, they are either weakening a joint, or just a member. If they are weakening a joint, then there is not much left to do other than completely replacing those members, a complete do-over.

If one member is being hurt lightly by the honeycombing, then you have some leeway. You can break off the part of the concrete that's affected (concrete with honeycomb area will break easily, indicating their weakness). When you are sure that you have cleared up the affected concrete, then you can apply adhesive material on the exposed surface, and recast the broken-off part.

Dog Legged Staircase - Design and Construction

When it comes to going up or down a multistoried building, staircases are the inevitable choice. They have been around for thousands of years since the dawn of civilization. Today, we will talk about the design and construction of the dog legged staircases – the most common form of staircases we know.

A staircase provides pedestrian access between various floors of a building. It consists of steps arranged in a rising array, called a flight. Each step has a tread and a riser. The tread is the horizontal part that you place your feet on, and the riser is the vertical difference between two stairs. Each group of steps is called a flight. A staircase generally has one, two or four flights between each floor – more than that is generally not preferred.

The most common type of staircase is the dog legged staircase, because it is the most economical, in terms of both construction cost and space occupied. This is because the staircase is arranged in two flights side by side, divided by a landing in the midsection. This is a very compact design requiring very little space and has a room-like footprint, thus allowing it to be designed in most positions in the building. The landing provides a bit of a resting area and wall opening opportunity.

Designing a dog legged staircase

Data given:
- Building usage: residential
- Space provided for staircase: 2.5 m × 4.5 m
- Height of a floor: 3.3 m

Design solution:
For residential buildings, the rise of each stair is kept at 150 mm, and the tread is kept at 225 mm. Therefore, the dimensions of the stair hall can be calculated in the following way:
- Area = 2.5 × 4.5 m2

There are two flights to cover a total rise of 3.3 meters. So,
- the height of each flight of stairs is 3.3/2 = 1.65 meters.

Now, we have to cross this amount of flight using 150 mm high steps. So,
- the number of steps needed in each flight would be: (1.65 × 100) / 150 - 1 = 10 risers
- (the last step is not counted since it's the landing or the floor height)

We have a 2.5 meter space to build our staircase. So,
- each flight would have to be this wide: 2.5 / 2 – 0.5 (for railing) = 1.2 meters.

That's the effective width of each stair.

Along the flight, the steps will take up total length = 225 × 10 / 100 = 2.25 meters. Since the provided area was 4.5 meters long, we still have 2.5 meter area left. This will go into providing the landing spaces, of which there are two. So,

- the effective breadth of the landing area is: (4.5 - 2.25) / 2 = 1.125 meter.

There you go, calculations are done for your dog legged staircase, now just draw it up!

Qualities of a good dog legged staircase

1. Located in an area accessible to every other room, with plenty of light and airing.
2. Optimum number of steps in a flight: a comfortable flight of stairs should have between 4 to 16 steps.
3. You should make sure that the angle of the staircase stays between 25 to 40 degrees, otherwise it would be difficult to traverse.
4. Make sure that the breadth of a landing is no less than the width of a stair.
5. It is advisable to have equal proportions between the flights of a dog legged staircase, otherwise it will break rhythm and you may feel weird when going up or down through that staircase. The human mind, by nature, likes symmetry.
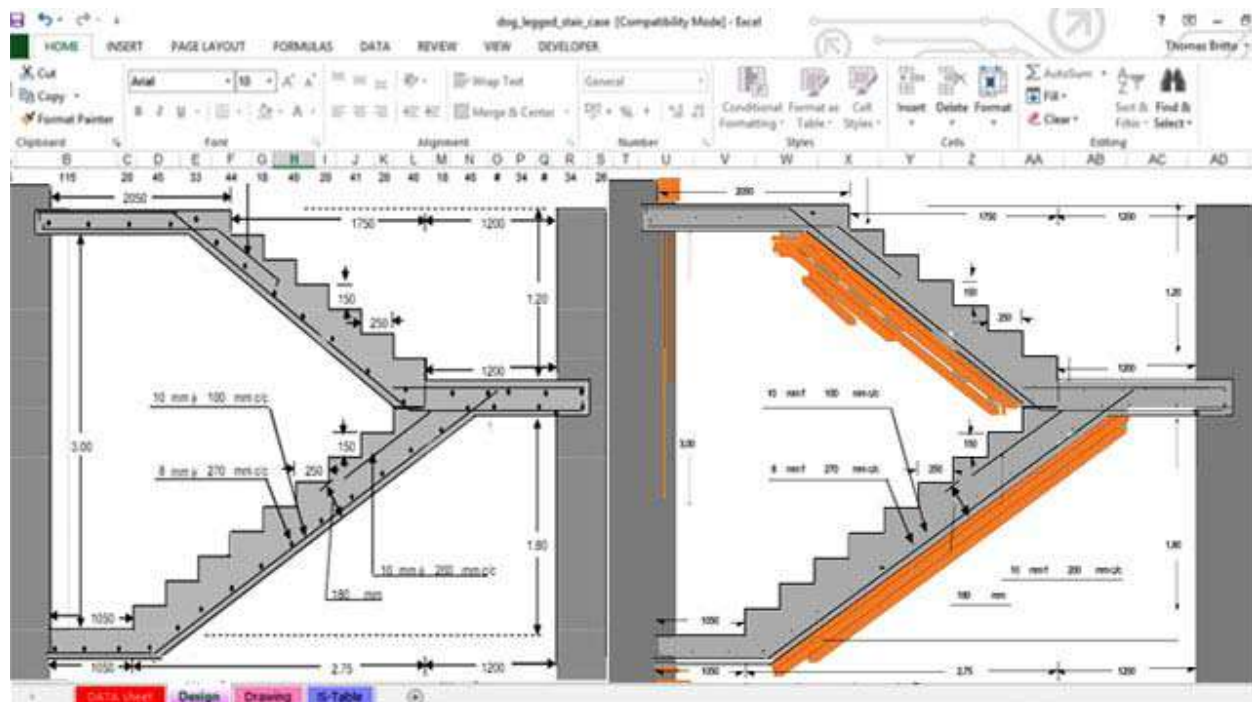
Calculating Load-bearing Capacity of Existing Beams

Repair and renovate is a big part of the construction industry. An engineer should be able to figure out the abilities of the existing structural members as well as build new ones. Today, we will see how you can go about calculating load-bearing capacity of existing beams that have cracked, weakened, or weathered out.

The method of calculating load-bearing capacity of existing beams is based upon measuring the dimensions of the beam in question thoroughly and precisely. Then you have to figure out the strength of its concrete and the reinforcement area within it. But that's not all, you have to further estimate the forces acting on this structural member.

When you are done taking these measurements and evaluation, then comes the calculation part. Specifications and equations provided in building codes like ACI 318-19 and IS 456 will come in very useful in this matter. And only after that you can figure out how that load-bearing capacity of the reinforced concrete beam will affect your repair or renovation work. This is a method called reverse engineering.

Step-by-step instruction on how to calculate the load-bearing capacity of an existing beam

1. A beam supports a slab, generally. Measure the span of the slab.
2. Now measure the span of beam.
3. Figure out the live load acting on the slab.
    a. This depends upon the purpose of the slab. E.g. The slab of an office floor should have 2.4 KN/m^2 force acting on it. Look it up in building code tables.
4. Estimate the self-weight of the slab
    a. Don't forget to add dead loads like tiles and other finished work.
5. Figure out how much of all that load is transferred to the beam in question.
    a. In case of a one-way slab, it's half, easily. For two-way slabs, it needs to be calculated by the tributary area.
6. Now calculate the RCC beam's own loads.
    a. Dead load of a beam = its own self-weight.
    b. Self-weight of a beam = 24 KN/m^3 x volume of beam.
    c. Total load = own dead load + any other loads on the beam transferred to it from slab or wall.
7. Figure out the total load on the beam using the above data and the suitable load combinations provided in the applicable building code.
8. Compute the applied moment (M_u) on the RCC beam in question.
    a. You can do this by either using required formula on the beams supports,
    b. Or, use finite element modeling.
9. Precisely measure the dimensions of the beam.
10. Find out everything about the steel bars provided in the beam.
    a. Can be found in the building's design detail, if available.
    b. If not, non-destructive tools can be used to scan the beam and find out.

c. If possible, you can break up a small sample from another similar beam that is not under use and see inside.

d. Ultimately, you need the size of the steel bars inside the beam, and their numbers.

11. Calculate area of reinforcement next.

12. Use above data to figure out:

a. The depth of the rectangular stress block

b. The height of the neutral axis

13. Final step: compute the design moment of the beam (M_d).

14. If Md is greater than M_u, then the beam is fine. If not, it needs to be fixed or supported.

So, of course, the repair or renovation work that you need to do on an existing beam depends clearly upon these two factors – the design moment and the applied moment. If you need to rehabilitate the RCC beam in question, that is, if M_u is greater than M_d, then you have to provide extra supports to the beam, or fatten it up – or even both, if needed.

## Example of load-bearing capacity of existing RCC beam

For example, if we have the following data:

- Beam dimensions: 250 mm X 380 mm X 350 mm
- Slab is one-way, 100 mm.
- Steel bars yield strength is 280 MPa, and concrete compressive strength is 17 MPa.

Then, using the above methods, we will find out that:

- M_d is 64.61 KN-m
- M_u is 93.218 KN-m

Since M_u is clearly much greater than M_d, this beam requires immediate repair and rehabilitation!
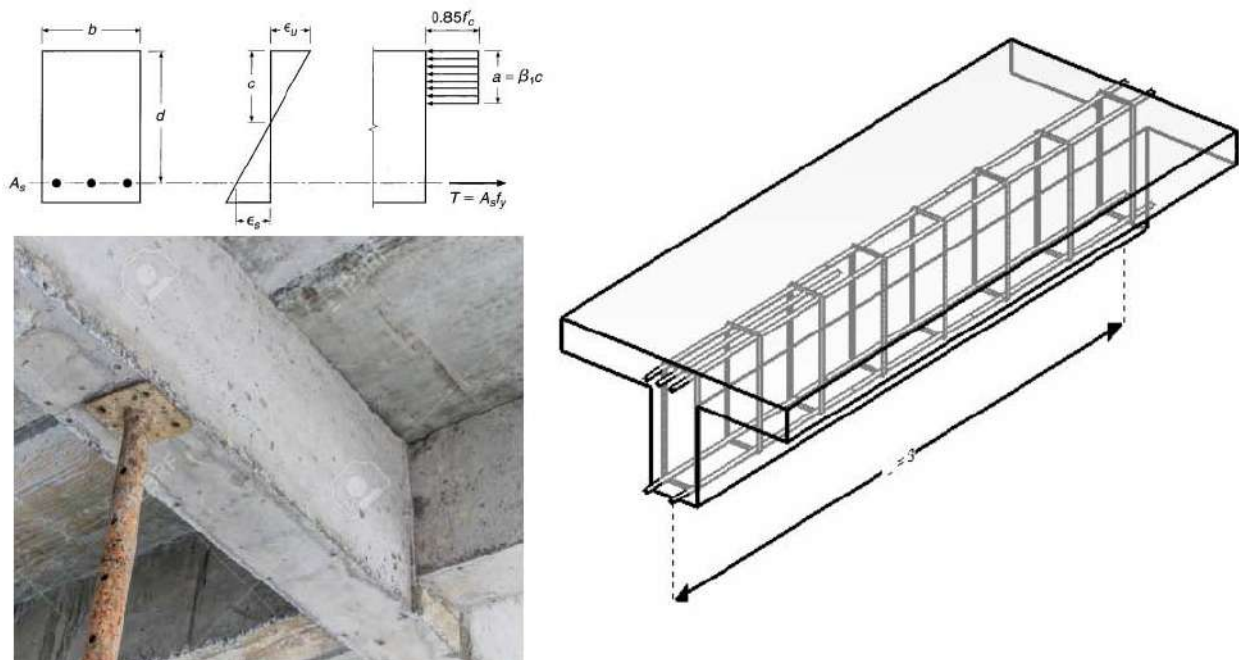
Important Civil Engineering Formulas and Metrics

If you are a civil engineer, you have to make may calculations in your head a lot, from every once in a while. Almost all of those will be related to the construction methodologies. Therefore, you need to remember quite a bunch of important civil engineering formulas and metrics. Today, we will list many such common construction formulas and information here.

The information and formulas here contain specifics that will help you to figure out essential details about steel bar weight per meter or total, construction materials quantity and weight, unit conversion criterion and factors, concrete grade ratios, and much more!

Important data in construction

A. Steel bar weights per meter

Bar Diameter	Weight in kgs
6	0.222
8	0.395
10	0.616
12	0.888
16	1.578
20	2.466
25	3.853
32	6.313
40	9.865

B. Length and other unit conversion figures

1 Unit	Converting to	Value
Inch	Millimeter	25.4
Foot	Meter	0.3048
Yard	Meter	0.9144
Meter	Foot	3.28
Millimeter	Inch	0.0394
Mile	Kilometer	1.6093
Newton	Kilogram	0.10

C. The weight of construction materials per unit volume

| Material	Weight per volume (kg/m^3)
Bitumen	1340
Cement	1440
Cast Iron	7650
Steel	7850
Ice	913
Petrol	690

D. Concrete Grades

Concrete is graded according to its compressive strength or force. The grade is indicated by a number after the letter 'M'. The bigger the grade number, the stronger the concrete. For example, M5 < M10 < M30 etc.

The 'M' means 'Mix', and the number denotes the numerical figure of the compressive strength of that type of concrete (at 28 days). So, when someone says they have used M10 grade concrete, it means they have used a type of concrete mix that would be able to hold up to 100 grams of force applied per square millimeters of that concrete after at least 28 days of settling.

Following are the ratio specifics of common concrete grades:

Concrete grade	Compressive strength	Mix ratio (cement: sand: aggregate)
M5	5 N/mm^2	1 : 4 : 8
M10	10 N/mm^2	1 : 3 : 6
M15	15 N/mm^2	1 : 2 : 4
M20	20 N/mm^2	1 : 1.5 : 3
M25	25 N/mm^2	1 : 1 : 2

Important formulas in construction
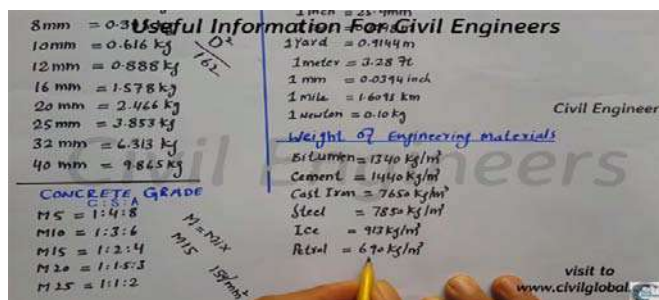
- Steel bars' weight: W is equal to (D ^ 2 x L) / 162 [D = dia of bar, L = length]
- Concrete: Width x Length x Height, divided by 27 = number of yards of concrete needed.
- Foundation Masonry Block: 8" high / 16" long / 3/8" mortar normal joint height.
- Roofing: Width x length, divided by 100 = number of squares of shingles needed.
- Siding: Width x Height, divided by 100 Square Feet = number of squares of siding needed.
- Carpet: Width of room x length of room, divided by 9 = number of square feet needed for room.

- Wood Siding: Width of board minus distance of lapping = coverage of wood siding per board.
- Width of area to be sided x height of area to be sided, divided by coverage calculated above = lineal feet of siding you need.
- Brick: 7 bricks = one square feet of coverage.
- Width of area to be covered x height of area to be covered, divided by 7 = number of bricks needed.
- Elevation Conversion: Elevation measured in 10ths per foot. 1 of elevation = one foot or 12" equals one foot.
- Normal measurement 12 inches per foot.

We hope the above information was useful to you. Please let us know your thoughts and suggestions using the contact portion below. Till next article, happy building!

Road Estimator - the Best Software for Road Contractors

Resources

You have your formulas, your spreadsheets, your cost estimating sheets – and then you have the Road Estimator 6.6. If you're a contractor or engineer in charge of road construction, the Road Estimator is an invaluable friend you must have in your PC!

A revolutionary software on its own, the Road Estimator is a great tool for road creation and quantity management estimates. This robust computer application can take care of all your section creation and quantity calculation. The software is so intuitive, it can generate roads and cross sections on its own from survey data, down to the last detail of earthwork and quantity.

Apart from road cross section calculation, the Road Estimator software can generate data for new roads, widen or strengthen existing roads, in any setting – urban, rural, mountains, highways.

Highlights of Road Estimator

New Roads
You're a road contractor and you gotta build roads! The Road Estimator is your best friend in this matter. Whether you are building new roads, single-lane, multi-lane, highways, service roads or rural roads – you will be able to get all kinds of estimation data from this exciting software. It can quantify roads with or without pavement, consisting of multiple layers, without any limitation of materials or the number of layers.

Widening of roads
Existing roads need to be widened as the load on them increases with time. The technical challenges of widening a road, especially in populated areas, can easily be overcome when you have the nifty Road Estimator by your side. Be it any kind of work – road repair, rebuild, soil replacement, cross-sectional changes, super elevation – just feed the survey data into the Road Estimator and watch the magic!

Strengthening of roads
Road is old and needs to be strengthened? No worries, feed the data into Road Estimator and it will automatically detect the issues with the existing road. The software will detect various road overlay conditions, and then compute the possible profile correction courses that will be highly beneficial for the existing road.

Railways (new!)
Not only roads, but the Road Estimator software can be used in making railways as well! Over the last few years, the demands of new rail network construction and upgradation of existing rail networks has gone through the roof. With that, the technical challenges associated with building rail networks has increased as well. If you're in charge of constructing a railroad, you know how important it is to get dependable estimates on each task. Road Estimate can immensely help you out in this matter – how so, read here.

Features of Road Estimator

- It has an in-built CAD editor that you can use for creating and adjusting road cross sections.
- You can import and export DWG files from Road Estimator.
- There are an unlimited number of road templates with the software.
- Supports single lane roads, multi lane roads, service roads, unlimited road layers, unlimited depth etc.
- Generated models will have complete integration of necessary road elements like rains, retaining walls, breast walls, gabions and user-defined elements such as crash barriers, fence, pipes etc. Even trees!
- The software can automatically detect the existing road for overlay construction. Then, Road Estimator will automatically calculate profile corrective courses based on the detected data.
- Median, carriageway, shoulder, side slopes with berms and berm-top slopes will get specified as per chainage. The slope and width will get automatic interpolation as well.

Why choose Road Estimator

1. User-friendly CAD interface
2. Template-based solutions
3. Drawing generation as built
4. Automatic PCC calculation
5. Supports all kinds of road elements
6. Ash layers integration
7. Easy design layers integration
8. Quick and precise reports
9. Auto embankment layer
10. Rapid data processing algorithm

So, what are you waiting for? Download Road Estimator today for easy and automatic detection of road issues and calculation. The Road Estimator is your best friend for your road construction, repair and upgrade work.
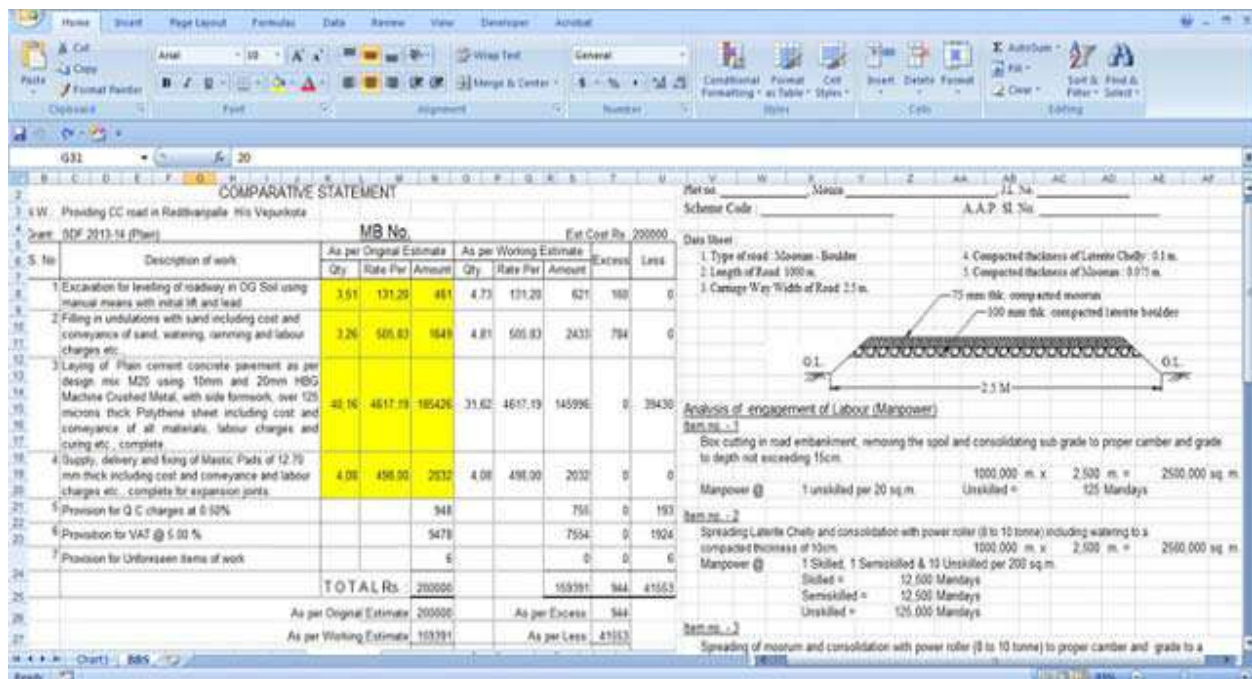
Top 5 Design and Construction Cost Estimation Templates

The AEC community will invariably concur that cost estimation of projects is probably the most vital part of the pre-construction phase, for any project. What good is a great design if it's not cost-effective, right? Therefore, today we will talk about the top 5 design and construction cost estimation templates.

A construction cost estimation is required at the end of design because the client will approve of only that design that can be built in his budget. No one has unlimited budget, and so your design has to be built in the budget the client specified. This is where construction cost estimation comes in.

Now, the problem is, constructing a building is a pretty complicated work. Even if you are building small projects, like a small residential house, you still have to take care of a lot of moving parts. The human mind simply isn't capable of remembering all the small details and tally them in head. Hence, you need a preformatted sheet to calculate the cost estimate of your project.

There are many such design and construction cost estimation templates available, but which one do you need for your project? Let's talk about the top 5 design and construction cost estimation templates below.

Shawn McCadden's Labor and Materials Cost Estimation Template

Shawn McCadden suggests that you separate the labor costs from the materials cost and handle them piece by piece. His cost estimation template is divided into the following:

1. Materials specification
2. Construction labors
3. Administrative costs

You have to manage each part separately in McCadden's sheet. This gives you the added advantage of figuring out a gross profit before you have to decide on a selling price – which may or may not be done by someone else.

These sorts of templates are particularly great for constructors who are used to having unique combinations of building requests from clients. Often these unique instructions require different types of labor and supplier management – so if you're facing that type of odd requests commonly, you'd better use this template.

The labor and materials cost estimation template of Shawn McCadden is available here:
https://www.shawnmccadden.com/request-shawns-excel-estimating-template?hsCtaTracking=14387bf1-ade4-4b88-9c17-1b56a85bab52%7C0b8a6136-ad2e-4fde-86cd-eeff0362217a

Budget vs Actual Costs Template

Among construction cost estimation templates, this one is quite unique since the Budget vs Actual Costs Template is especially good for comparing the costs expected and projected. This is a quite simplistic template greatly suitable for smaller projects. Focusing on how the budget is managed throughout the project workflow is how this template works and could be very useful for projects

that aren't much complicated and would finish in a short while.

The Budget vs Actual Costs Template gives you a high-level product specification sheet to calculate your project costs. You have an easy but highly adaptable working mechanism provided via this sheet, which will also let you figure out how well you're doing in terms of the provided budget. Another great thing about this sheet is that it adds a whopping whole 10% extra contingency costs to the totals, in case you run into any issues.

You can get the Budget vs Actual Costs Template here:
https://www.fohlio.com/blog/wp-content/uploads/2018/07/budget-actual-estimate-template.xlsx

However, it is available for personal use only.

Building Advisor Construction Cost Estimator
While it is not exactly a cost estimating sheet, the Building Advisor site is great for the constructors for deciding if their building design is realistically acceptable under expected budget

or not. Not only builders can estimate the various costs for a project using their templates, they can also use them for record-keeping.

The general template the Building Advisor site gives is nicely laid out in minute details of the general requirements and site preparation respectively and manages then separately. This gives you the advantage of dividing your actual construction costs and auxiliary costs – and delegate them, if necessary.

This sheet divides labor costs and material costs for each category, and provides a real-life cost value beside the estimated cost value, so that you can easily see how close to reality your estimates were. This template, obviously is built to last throughout the project, not only just for the beginning.

You can see the options about how to get the Building Advisor Construction Cost Estimator sheet here:

https://buildingadvisor.com/project-management/estimating-overview-2/

Soft Costs vs Hard Costs Template

Categorizing everything into soft and hard costs, this construction cost estimating template is especially useful for builders who focus on residential and light commercial construction entirely. In these matters, costs can be defined as soft costs, that are not directly related to building a structure but you have to pay them anyway, like legal fees. The rest of the expenses that go directly into constructing the building are called hard costs.

Hard costs can be further divided into Drywall and Completion. Drywall costs include what you need to do to erect a structure like walls and floors, and completion includes expenses what you need to do after erecting the walls like plumbing and electrifications. These categorizations are obviously going to be very useful for constructors who generally erect small housing and shops.

This small but handy Soft Costs vs Hard Costs Template can be downloaded here:
https://www.fohlio.com/blog/wp-content/uploads/2018/07/designconstruction.xlsx

Material Estimate of an RCC Underground Water Tank

Videos

Dating back to the early days of civilization, water storage facilities have been a part of the construction industry forever. Today there are many smaller pre-built water tanks available in the market, but more often than not we have to custom-build our water storages. To build one of them, you have to know about the amount of construction materials it needs. Today, we will give you a sample materials estimation of an RCC underground water tank.

Depending upon the usage and scenario, there can be many types of water storage tanks. Especially in dry areas, you have to do some serious thinking about how exactly would you want to store your water. Because you need a consistent supply of water without getting it wasted or overdrawn.

Types of water tanks
Here are some common varieties of water storage tanks we can find:

Drinking water tank
These are either small portable tanks, or fixed large vertical tanks. Either are generally cylindrical in shape. Sometimes filtering equipment are fitted on the outlet of the tanks. They require regular maintenance and cleaning.

Fire suppression tank
Some builders employ a large tank (or a system of them) connected to the sprinkler system in the building. These tanks aren't generally used but kept full as backup.

Irrigation tank
Depending upon if you want to irrigate your field or water your plants, the irrigation tanks can be large or small. They don't require filtration systems and so much regular cleanup. These are connected to the irrigation channels via regulator or to the garden sprinklers or hose.

Waste water storage
These are generally large, underground vaults used to hold sewage. They may be connected to the drainage lines or may not.

Calculating Water Tank Installation Estimates

We have the following data:
- RCC water tank is circular.
- Plain cement concrete = 1:2:4 with thickness = 10 cm.
- RCC = 1:2:4 with thickness = 10 cm.
- Opening for water tank is 60 cm with thickness = 10 cm.
- Thickness of RCC walls = 15 cm.

- 1% of 4M bars is used in wall.
- Depth of wall = 3 meter.
- Diameter of center hole/circle = 4 m.
- Diameter of extra wall is 15 cm.
- Diameter of outer wall is 10 cm.
- Diameter, of center is the hole in section = 4.15 cm up to the wall
- Diameter of PCC = 4.5 cm.

Therefore, the calculations will go as per the following:

Diameter of PCC:
- = 4 + 0.15 * 2 + 0.10 * 2
- = 4.5 meter

PCC work:
- π/4 * (Diameter of PCC)2 * Thickness of PCC
- = π/4 * (4.5)2 * 0.1
- = 1.59 m3

RCC work for walls:
- π/4 * (D2)2 * Thickness
- = π/4 * 4.3 * 0.15
- = 2.178 m3
- π/4 * ((D2)2 – (D1)2) * Depth
- = π/4 *((4.3)2 – (4)2) * 3
- = 5.867 m3

RCC work for 10 cm slab (1:2:4):
- = π/4 * (D2)2 * Thickness
- = π/4 * (4.3)2 * 0.1
- = 1.452 m3

Deduction for hole:
- π/4 * (D3)2 * Thickness
- = π/4 * (0.60)2 * 0.1
- = 0.0282 m3

RCC work for slab after deduction:
- = 1.452 – 0.0282
- = 1.423 m3

Total RCC:
- (2.178 + 5.867 + 1.423) m3
- = 9.468 m3 * Steel
- = 1/100 * 9.468
- = 0.09468 m3
- = 0.09468 * 7850
- = 744 kg steel required

Total net RCC:
- = 9.468 – 0.09468
- = 9.373 m3

Total cement, sand, and crushed stone volume:
- = 9.373 + 1.59
- = 10.963 m3

Ratio:
- Cement: Sand: Aggregate
- Material = Ratio of material/Sum of ratio * Dry Volume
- Cement = C/C+S+CA * Dry Volume
- Sand = S/C+S+CA * Dry Volume
- Total concrete work = 10.963 m3
- Ratio = 1:2:4
- Sum of ratio = 7

Sand required
- = 2.41 * 2
- = 4.82 m3

Aggregate required
- = 2.41 * 4
- = 9.64 m3

Steel bar required:
- = 744 kg (as found above).

- Dry Volume = Wet Volume * 1.54
- 10.963 * 1.54 = 16.883 m3
- Materials = Ratio of materials/sum of material * Dry Volume
- Cement = 1/7 * 16.883 = 2.41 m3
- We know, 1 bag of cement in m3 = 0.035

Therefore,

Cement bags required:
- = 2.41/0.035
- = 68.8 bags
- = 69 bags

Description	No	L	B	H/T	QU	R
Excavation.	1	5.40	3.40	2.35	43.15	L=5 +0.20 +0.20
PCC (1:4:8).	1	5.40	3.40	0.15	2.75	
RCC (1:2:4).						B=3+0.20 +0.20
1)In floor	1	5.40	3.40	0.20	3.67	
2)In walls						L=5 +0.20 +0.20
Long walls	2	5.40	0.20	2	4.32	
Short walls	2	3.00	0.20	2	2.40	L= 5.40 m
Slab	1	6.00	4.00	0.15	3.60	
Total RCC					13.99	
Deduction for MH	1	$\pi 0.25^2 \times 0.15$			0.029	
Total net RCC		13.99 - 0.029 =			13.96	
Steel in RCC @ 1% of RCC		$\frac{1}{100} \times 13.96 = 0.1396 m^3$			=1096 kg	

Abstract of quantities — SLK's TuTs

RCC slab 15cm
MH 50cm dia
G.L
RCC 20cm thick 1% steel
30cm
500 x 300 x 200 cm
PCC 15cm thick
500 x 300 x 200 cm
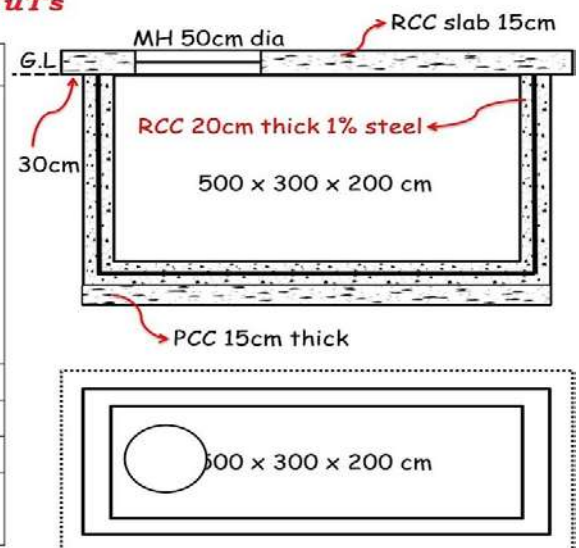
Calculating Loads Acting on Columns, Beams, Walls, and Slabs

It is essential that you have to be able to calculate the forces acting on different members of a structure quickly and efficiently, if you wish to be a civil engineer worth your salt. There are some very simple ways to do it. Today, we will talk about calculating loads acting on columns, beams, walls and slabs.

Calculating Loads Acting on a Column

About columns

A column is a vertical compression member in a structure. They are supposed to be at least three times taller than their breadth, and axial loads fall on them. That is, the weight of the superstructure goes through a column to the foundation safely. It is, therefore, a very important member of any RCC structure.

Column load calculation

We have the following data:
- Self-load of concrete: 2400 kg/m³ = 24.54 kN/m³
- Self-load of steel: 7850 kg/m³
- Column size: 300 x 600 mm cross section, 2.55 m height

Therefore,
- Self-weight of column
    - = 1000 kg per floor
    - = 10~12 kN or close
- Volume of Concrete
    - = 0.30 x 0.60 x 2.55
    - = 0.459 m³
- Weight of Concrete
    - = 0.459 x 2400
    - = 1101.60 kg
- Weight of Steel (1%) in Concrete
    - = 0.459 x 1% x 7850
    - = 36.03 kg
- Total weight of column
    - = 1101.60 + 36.03
    - = 1137.63 kg
    - = 11.12 kN or close

Calculating Loads Acting on a Beam

About beams

Beams are horizontal members of a building which carry both the horizontal and vertical loads to the columns or girders. They also take care of the bending moment. Previously, we used to make beams out of stone or wood. But with the increasing weights and taller structures, we have to make RCC beams.

Beam load calculation

The calculation of beam loads is quite similar to column load calculation. We will use the same metrics here.

We have the following data:
- Self-load of concrete: 2400 kg/m³ = 24.54 kN/m³
- Self-load of steel: 7850 kg/ m³
- Beam size: 300 x 600 mm cross section (excluding slab thickness), calculating for every 1 meter of length

Therefore,
- Volume of Concrete
  - = 0.30 x 0.60 x 1
  - = 0.18 m³
- Weight of Concrete
  - = 0.18 x 2400
  - = 432 kg
- Weight of Steel (2%) in Concrete
  - = 0.18 x 2% x 7850
  - = 28.26 kg
- Total weight of beam
  - = 432 + 28.26
  - = 460.26 kg/m
  - = 4.51 KN/m or close

Calculating Loads Acting on a Wall

About walls

Walls are those structural elements which provide shape, division and shelter to a space in a building. They can be either outer walls which are thicker and stronger, or inner walls that exist simply to divide the space.

Wall load calculation

Assuming we are using standard clay bricks for the wall.
We have the following data:
- Density of bricks: 1800~2000 kg/m³
- Wall thickness: 9 inches (standard outer wall in residential construction)
- Wall height: 2.55 meter (same as column)
- Wall length: calculating for each 1 meter

Therefore,
- Wall load per running meter
  - = 0.230 x 1 x 2.55 x 2000
  - = 1173 kg/meter,
  - = 11.50 kN/meter or close
- If, however, we are using ACC blocks then the density of those bricks are 550~650 kg/m³
- In that case, using the same method as above, we get the load
  - = 3.74 kN/meter or close.

Calculating Loads Acting on a Slab

About slabs
A slab is a flat monolithic plate-like structural element that provides a floor for something. They can be built as foundations to support the whole building, or they can be raised on top of columns and beams to make floors. Sometimes if the slab is light and small enough, it can be supported by just walls – though it is not recommended.

Slab load calculation
We have the following data:
- Slab thickness: 150 mm
- Slab size: 1x1 meter (calculating for each square meter)
- Floor Finishing load: 1 kN/meter
- Superimposed live load: 2 kN/meter
- Wind Load: ~2 kN/meter

Therefore,
- Slab Load Calculation
  - $= 0.150 \times 1 \times 2400$
  - $= 360$ kg
  - $= 3.53$ kN or close
- Total slab load
  - $= 8{\sim}9$ kN/m^2

Sustainable Bridge Construction

Environmental factors like carbon footprint and sustainability are often coming to the front when talking about building a new structure these days. With the advancement in understanding the reality of climate change, most clients are opting for green building solutions. Heavy construction and infrastructure are no exception either – and that's where today's talk about sustainable bridge construction comes in.

Factor affecting sustainable bridge construction

NEWS

True sustainable architecture and construction revolves around three major factors – social, environmental, and economic. The construction of a heavy structure like a bridge will inevitably depend upon the resources available to the constructor, the manpower and the location constraints. To make it a sustainable construction, the constructor has to balance out the supply and demand.

The bridge must not damage the environment, as far as possible, and yet must supply the support it is required to give to the road or rail way passing over. Not only that, it should also improve the social situation of the surrounding area. And it has to do all that within budget.

Social Factors
Bridges exist mostly to serve the community it is built near. This is so obvious that we don't even think about it anymore – but it has to be considered specifically in case of sustainable bridge construction. A sustainable bridge needs to serve not only the present population, but also be able to support the future generations of the area and the increasing loads.

Environmental Factors
Possibly the most important factor in sustainable bridge building, reducing carbon footprint and energy consumption both in the construction process and later in service is the prime target here. Each member of the AEC community involved in constructing a sustainable bridge will have to be environmentally responsible.

While the construction industry has improved many times in terms of green building in the last two decades, we still aren't good enough it sems. So, to make the bridge truly sustainable, the constructor, again, must keep the balance positive.

Economic Factors
This part should be fairly straightforward – the construction and maintenance costs of the bridge must be less than the benefits it generates. That means constructing in such a way to minimize construction costs, but also making it as much maintenance free as possible.

Obviously, profit is ultimately the decisive factor in any business. Any project that isn't going to be cost-effective is not going to be accepted by any constructor. Again, a positive balance has to be maintained – this time, by the client.

Sustainability in bridge construction

While this science is still in its rookie uniforms, there has been major advances made in the matters of sustainable bridge construction. The reason for this can be the simple fact that, if a bridge lasts for 300 years instead of 100 years, then it reduces its environmental impacts by 66% directly, according to Man-Chung Tang, a sustainable engineering expert.

To be sure, the maintenance costs are the prime reason of worry in case of sustainable bridge building. In UK alone, there are over fifty thousand bridges, but they are covered by a meager 6 billion pounds till 2021. This is definitely not enough. It would be better to replace these bridges with sustainable bridges that will last much longer with much less maintenance. Sure, the initial investment could be high – but considering the inflation that is sure to come, it's worth it!

A hidden factor in sustainable bridge construction is Education, which is surprisingly quite easy to overlook. Future engineers need to be well-learned in environmental studies as well as sustainable architecture all through their general and specialized studies – the state of which is now, frankly, disappointing.

Few engineering students get to learn green building as a part of their main course, and even if it is there, it's considered as an extra, not a necessity. And of course, almost all of the present green building experts in the world are self-taught. Unless this status changes, we cannot expect changes in sustainable construction in effective mass scales.

Top 5 Trending Practices in Construction

With the fourth technology wave, the world is changing fast and with it the construction industry is changing as well. Even with the impact of the Covid-19 pandemic, the construction sector is a booming and growing sector – but with rapid alternations. Today, we will talk about the top 5 trending practices in construction.

By default, the construction industry is rather slow to adapt to new practices, compared to other businesses. Generally, the same construction trends stay in practice for years with minimal adjustments. However, in the last few years, increased technological awareness, digital breakthroughs, and changed market demands have forced the hand of the traditionalists in the industry – they have to adapt to the new era of construction or go extinct.

Therefore, without further ado let's jump into the top 5 trending practices in construction.

1. Green Building

With the advances of awareness in global warming and the climate change factor, the market is shifting rapidly towards using sustainable, clean technology in every sector, and the construction industry is no exception. Using minimal waste construction methods to build high energy efficient buildings that are built from recyclable materials and are reasonably self-sufficient is becoming one of the top trends in construction industry these days.

At the present, buildings consume about 40% of the total energy produced in the country, and they are responsible for around 30% of the total greenhouse gas emissions. This is a huge area where many improvements, in the methodology of green building, can be implemented to stave off climate change – or at least minimize its adverse effects.

Naturally, any modern person aware of the situation wants that. Which leads to both market and government pressure to increasingly utilize green building practices in the construction industry. Lowering the carbon footprint of constructing a structure, and making it efficient and sufficient enough to reduce energy consumption substantially – both of these will most definitely be the selling factors to the next generation.

2. Drones

Everybody loves drones! And for good reasons, they are going to be the future best trend in construction industry. And it's not just taking real estate photos, either. Drones, being as agile as they are, and being able to go where humans cannot, are extremely good at surveying and scrutiny.

In the design phase, drones get to be invaluable when linked to a BIM central brain. The data flowing in from drone flights can precisely build up a detailed 3D model of an area or structure – automatically, even. The real-time actionable data helps immensely in the decision-making parts, streamlining the whole design process.

Sturdier drones and automated build-bots are now being used as well, in both hazardous situations or where speed or manpower is a big factor. Security drones can be employed to prevent intentional loss as high as a billion dollars every year. Some heavy drones are already

being used to observe and scrutinize the actual construction process, alerting the authorities at once if anything deviates from design.

Usage of drones in construction industry continues to grow, and is estimated to grow twice – even thrice, maybe – just by the end of 2021. This is the bandwagon to jump on – and the market isn't waiting for the traditionalists.

3. AR and VR

Probably the most futuristic trends in construction industry in use right now is the usage of Augmented Reality and Virtual Reality (AR & VR). Isn't it cool to be able to see the building before it is built, to be able to walk through the rooms and corridors, to suggest improvements and changes as you look around in your house-to-be? AR and VR enables this extremely useful practice.

AR and VR works by taking the realistic renderings of the finished 3D model and presenting it to you in a 3-dimensional visualization system. This is mostly done using wearable technology, but also 360-degree visualizations can be used.

As clients are able to see the project as it will become before it actually exists and suggest changes, developers also benefit from the use of AR and VR in construction industry. This includes automated measurements, in-person area survey and real-time data sync with a BIM brain, simulations, safety training... the limit is only the imagination.

4. Building Information Modeling (BIM)

Information modeling is not new to the digital era of the construction industry, but nothing does it better than BIM software. According to Autodesk, BIM is "an intelligent 3D model-based process to help professionals manage buildings and infrastructure."

BIM enables the user to generate and manage complete project information in a 3-dimensional manner, using any level of detail they like. Furthermore, a BIM central server enables the whole AEC community to collaborate on another level entirely! Because BIM changes on the cloud are real-time, everybody involved in the construction of a particular project gets to see every change, in realistic 3D model and in documentation, just as they happen somewhere else.

For those great reasons, and many more, the AEC community is getting more and more aware of BIM and many have willingly made it their lifeblood. No wonder that the market from BIM is expected to grow up to $15 billions in a few years, conservatively put. BIM is definitely going to become the digital spine of the construction industry.

5. Prefabrication

Why build everything from the ground up, when you can just snap pre-built things together? The usage of prefabrication in construction industry, especially when it comes to building repetitive stuff like residential zones, offers immense benefits.

First of all, prefabrication is a big part of green building – you don't need to waste energy and materials and carbon to make everything on-site. Instead, most of the walls and other members, even whole rooms, are made in a controlled manner in a dedicated facility with very little emission and waste. Then you just carry them off to the site and snap them together.

This method is not only green – it is also surprisingly much cheaper than the traditional method. Not to mention, since you are working with ready-made stuff, a prefabricated building is much easier, safer and faster to erect than the same building done in traditional methods, and requires much less manpower. Furthermore, prefab buildings are generally very energy-efficient, sustainable, and obviously, easy to tear down and recycle.

It's easy to see why the market for prefab and modular buildings will grow by a hundred billion dollars within just a couple of years. Major international constructors have expressed their intention to reduce their on-site activity by 75% by 2025, relying mostly on ready-made building parts. All of that makes this the perfect time to jump into prefabrication if you're in the construction industry!

USA Top 5 Mega Construction Projects in Progress

Even though the recent pandemic issue has seriously hurt the US construction industry, even then, America is well-known for its infrastructure and habitat development work. There are lots of giant construction works ongoing in every state of the USA – some are nearing endline and some have just started. Today, we will talk about the USA top 5 mega construction projects in progress.

Here is the list of the top 5 mega projects under construction in the USA:

1. California High Speed Rail
2. Sound Transit 3
3. Las Vegas Convention Center People Mover
4. Hudson Yards – New York
5. Second Avenue Subway

Now, let us get familiar with each of these construction projects.

California High Speed Rail

The California High Speed Rail project, or CHSR is undergoing construction in the State of California, connecting Anaheim and Los Angeles to San Francisco. When complete, this 380-mile journey will take just a bit over two and a half hours. Estimated cost of this project is $77 billions, making it sitting pretty on top of our list.


The best thing about this project is that it is a publicly funded high-speed railway construction project in the U.S., of which there aren't many. The end stations of this line are the Anaheim

Regional Transportation Intermodal Center, the Union Station in LA, and the Salesforce Transit Center in 'Frisco.

Sound Transit 3 (ST3) Construction Project

The people of Seattle wanted a change in the transportation infrastructure, and they got it. By a ballot measure, the Sound Transit 3 project won by 54% votes, which is basically a major expansion of the existing transportation system in place in the state of Washington.
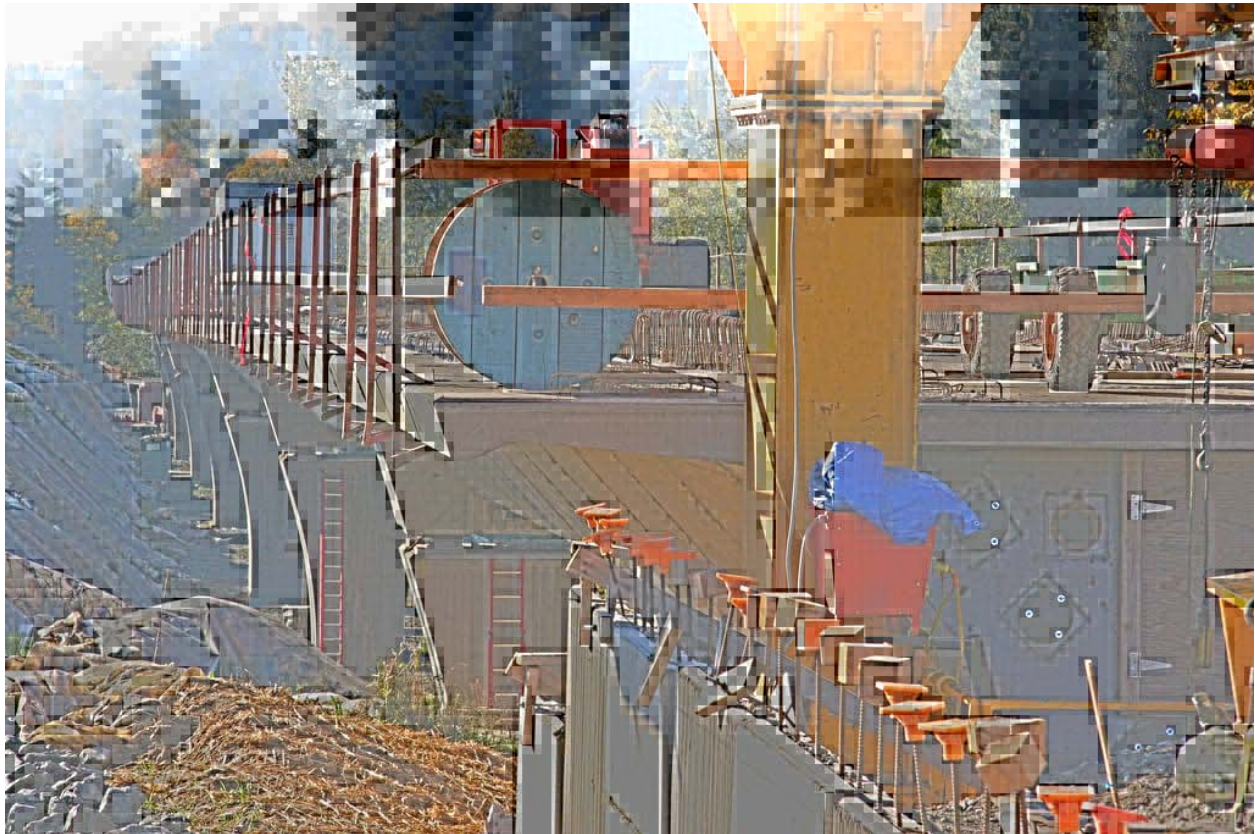

mass transit achievements so far, helping people move around Tacoma, Federal Way, Everett and Issaquah, as well as the Seattle neighborhoods of Ballard and West Seattle. This expansion and upgrade of the system will mostly be on the light rail network in those parts.

Las Vegas Convention Center People Mover

Elon Musk's Boring Co. Is anything but boring when they get to the boring! The first commercial tunneling project of this company (previously they did mostly R&D stuff and other) is a combo of twin giant veins dug underneath Las Vegas.

The Vegas People Mover project is going to cost well above $52 billions, but it will be able to move nearly 4,500 passengers per hour! When complete, self-driving electric vehicles will whisk off people the entire 1.5 mile length of the tunnel in under two minutes. One of the tunnels had already completed by May, and the rest of the work will be finished by Early 2021.
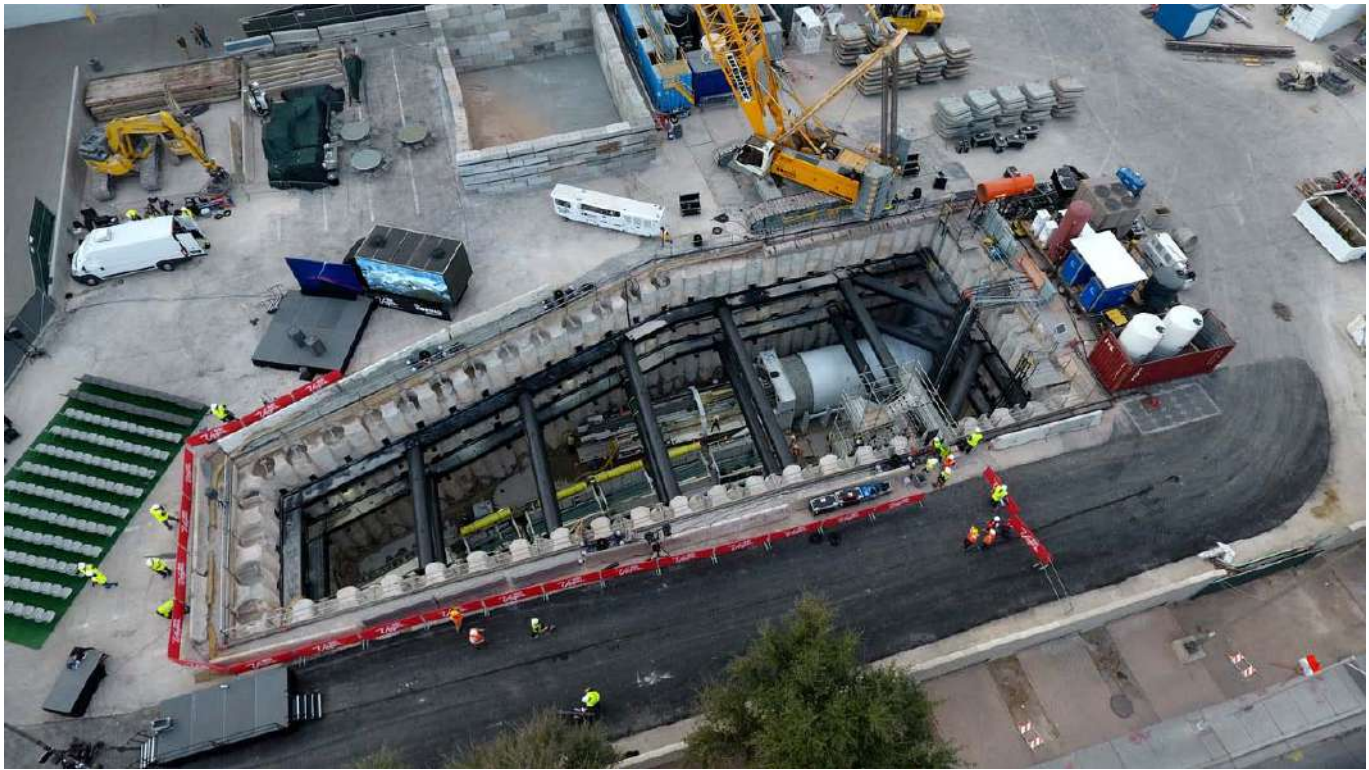
The Hudson Yards in New York
The only residential project on our list got on by its whopping $20bn construction cost estimate.

The Hudson Yards is located on the west side of midtown Manhattan, beside the West Side Highway. Since the Rockefeller, this is the biggest single urban real estate development in the state of New York.

In the Hudson and Chelsea neighborhoods of NYC, most of the project will be constructed upon a platform built over the West Side Yard (a storage depot for Long Island Railroad trains). Punctuated by 30th Street in the south and the 43rd Street in the north, this giant 28 acre residential project is being developed by NYC Department of City Planning and NYC Economic Development Corporation.

Second Avenue Subway Line

The big apple is always growing bigger! Another addition to our top 10 USA construction projects is the Second Avenue Subway line in the East Side Manhattan, running under the Second Avenue. The subway line will run 8.5 miles long from Harlem 125th Street to Hanover Square, able to serve well over five hundred thousand passengers every day.

Interestingly, this massive $17 billion USD project was proposed first a hundred years ago! At that time, this expansion was envisioned to be a part of what would be the Independent Subway System of New York City. The first phase of this huge construction project (72nd Street to 96th Street) is already complete and running. The second phase is under construction but may eat up another two billion.