

3.2 Contact Pressure and settlement

The stability of structure is majorly depending upon soil – foundation interaction. Even though they are of different physical nature, they both must be act together to get required stability. So, it is important to know about the contact pressure developed between soil and foundation and its distribution in different conditions which is briefly explained below.

Generally, loads from the structure are transferred to the soil through footing. A reaction to this load, soil exerts an upward pressure on the bottom surface of the footing which is termed as contact pressure.

Contact Pressure Distribution under Footings:

The distribution of contact pressure under different types of footings on different types of soils are explained below.

1. Under Flexible Footing
2. Under Rigid Footing

1. Contact Pressure Distribution under Flexible Footing:

cohesive soil:

- For flexible footing on cohesive soil, settlement is maximum at center of footing and minimum at the edges which forms bowl like shape as shown in below figure. But the contact pressure is distributed uniformly along the settlement line or deflected line.

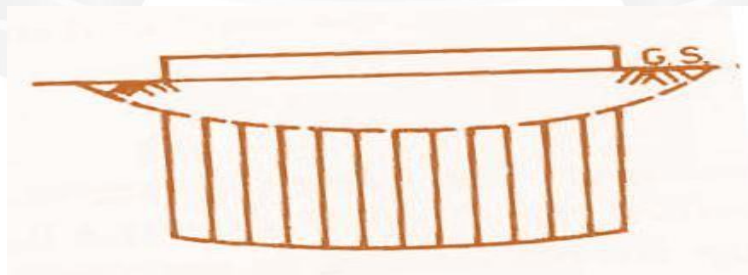


Fig 1: Contact Pressure Distribution - Flexible Footing - Cohesive Soil

[Fig1 <https://theconstructor.org/geotechnical/soil-foundation-contact-pressure-distribution/5647/>]

Cohesionless soil:

- When a flexible footing is laid on the Cohesionless soil, settlement at center becomes minimum while at edges it is maximum which exact opposite case of the settlement of flexible footing over cohesive soil.
- But in this case also contact pressure is uniform along the settlement line which is shown in below image.

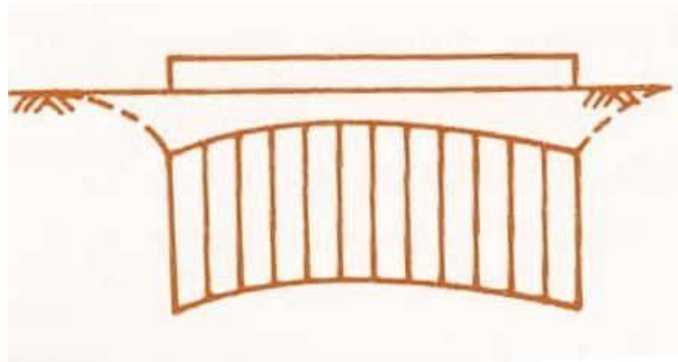


Fig 2: Contact Pressure Distribution - Flexible Footing - Cohesionless Soil

[Fig 2 <https://theconstructor.org/geotechnical/soil-foundation-contact-pressure-distribution/5647/>]

2. Contact Pressure Distribution under Rigid Footing

cohesive soils:

- For rigid footings resting on cohesive soils, settlement is uniform but contact pressure varies. At edges contact pressure is maximum and at center it is minimum which forms inverted bowl shape as shown in below figure.
- The values of stresses at edges becomes finite when plastic flow occurs in real soils.

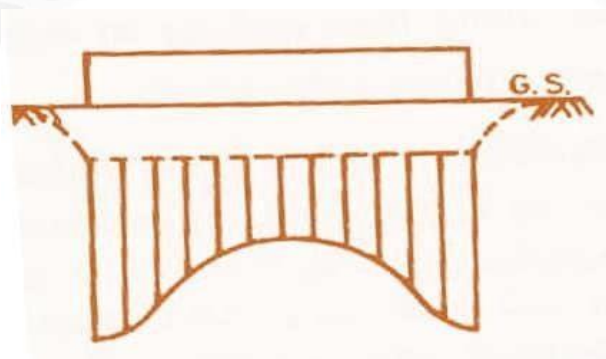


Fig 3: Contact Pressure Distribution - Rigid Footing - Cohesive Soil

[Fig 3 <https://theconstructor.org/geotechnical/soil-foundation-contact-pressure-distribution/5647/>]

Cohesion less soils:

- If the footing is resting on Cohesion less soils, contact pressure is maximum at center and gradually reduces to zero towards edges. Settlement is uniform in this case also.
- If the footing is embedded, then there may be some amount of contact pressure at the edges of rigid footing.

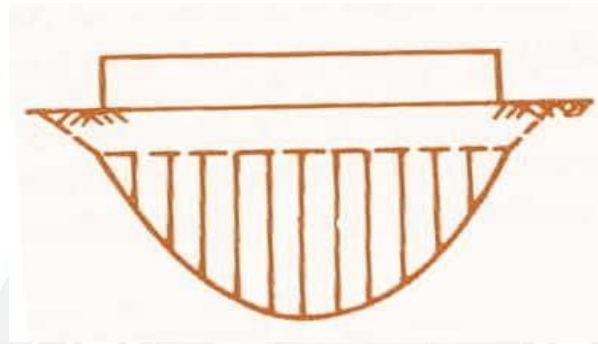


Fig 4: C.P Distribution - Rigid Footing - Cohesionless Soil

[Fig4 <https://theconstructor.org/geotechnical/soil-foundation-contact-pressure-distribution/5647/>]

Factors Effecting Contact Pressure Distribution:

Following are the factors effecting contact pressure distribution

- Stiffness of Footing
- Compressibility of soil
- Type of loading

1. Stiffness of Footing

- Contact pressure is uniform in case of flexible footings such as earth embankments. Contact pressure varies in case of rigid foundations such as R.C.C pad foundations etc. If the footing is partly flexible and partly rigid like raft foundation, contact pressure slightly varies.

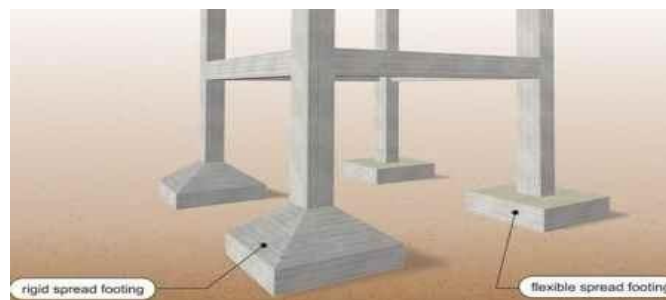


Fig 5: Flexible and Rigid Footings of a Structure

[Fig 5 <https://theconstructor.org/geotechnical/soil-foundation-contact-pressure-distribution/5647/>]

2. Compressibility of soil:

Compressibility or stiffness of soil also plays a role in contact pressure distribution. If the soil is coarse grained, contact pressure is more at the center of foundation than edges whereas in case of clayey soils contact pressure is uniform.

3. Type of loading

a) Concentrated Loading

- If concentrated loading is applied at the center of foundation resting on cohesive soil, contact pressure is not uniform irrespective of stiffness of foundation.
- For flexible foundation, contact pressure is maximum exactly under the load application.
- For rigid foundations, contact pressure is maximum at edges. So, application of point load on rigid foundations can be comparable to the application of uniform loading on rigid foundation resting on cohesive soil.

b) Uniform Loading

- Contact pressure distribution under uniform loading and deformed patterns of flexible and rigid foundations are already explained above with figures 1, 2, 3 and 4.

General Assumption of Contact Pressure Distribution

- In the design of foundations, Contact pressure is assumed to be uniform which is not a problem for flexible foundations since they have uniform contact pressure irrespective of stiffness of soil.
- But when it comes to rigid foundation, this assumption may lead to unsafe design since contact pressure is not uniform in this case. This happens when the soil acts as elastic material.
- However, the soil under footing acts as elasto-plastic material just before failure occurs. Hence, this assumption can be justified at the ultimate stage.