



# PLASTIC SETTLEMENT CRACKS

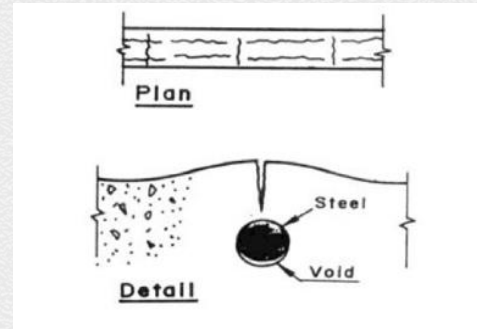
What, Why & How?

## INTRODUCTION

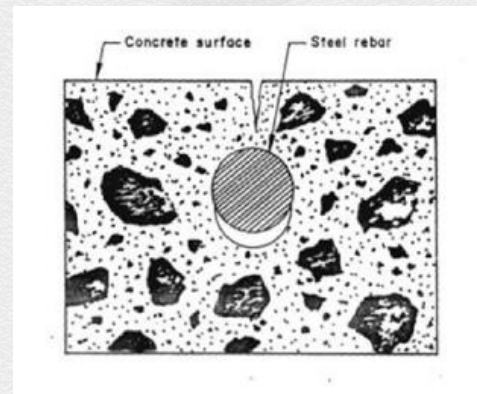
Plastic settlement cracks occur in newly poured cement concrete within reinforced structures. (Figure 01). These cracks can appear on the surface before the concrete sets, especially when there is significant bleeding, high-flow concrete, high vibration efforts, high evaporation rate, and when there are obstructions, such as reinforcement bars, hindering the settling of solids. (Figure 02.)

When fresh concrete is placed in deep formwork, such as high thickness slab/ foundation, walls or columns, it naturally settles or subsides. If this settling is restricted by obstacles like steel bars or large aggregates, it can result in short horizontal cracks in some certain areas deep till steel mesh surface (Figure 01).

Moreover, these obstacles can cause the concrete above them to sag by creating voids underneath. This settling, caused by a decrease in volume, is referred to as plastic settlement cracks.



(Fig. 01)



(Fig. 02)

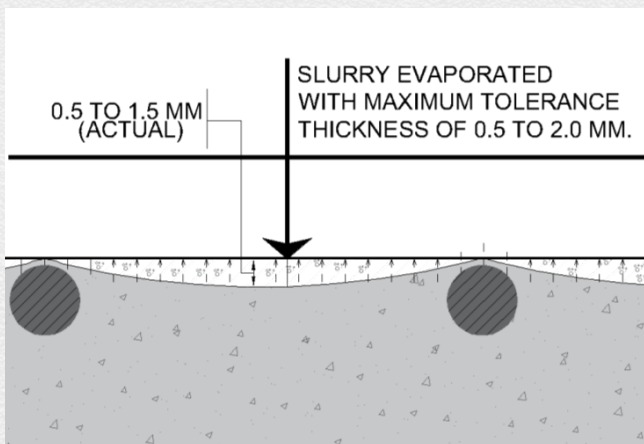


Figure 03. (Slab Section Details)



Figure 04. (Steel Mesh on Slab Surface)

## TYPES OF PLASTIC SETTLEMENT CRACKS

When fresh concrete is placed in column or wall formwork, it naturally settles or subsides. If this settling is restricted by obstacles such as reinforcement bars or large aggregates, it can result in plastic settlement cracks.

Settlement cracks occur when the solids in concrete are allowed to settle freely without any hindrances, leading to a decrease in the volume of mortar paste, especially the concrete cast for horizontal elements with enough depth.

Below are descriptions of some common plastic settlement cracks.

## CAUSES OF PLASTIC SETTLEMENT CRACKS IN FRESH CONCRETE

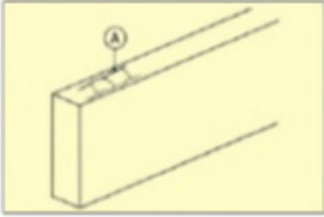

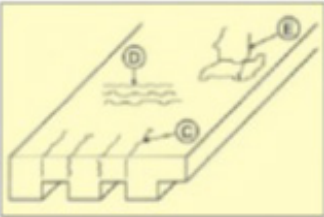
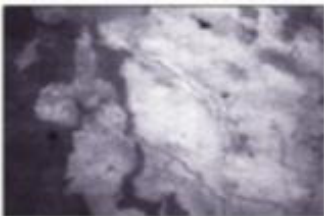
	<p>Reinforcements which are closer or nearby the top of a concrete section can develop plastic settlement cracks. If the formwork is relatively narrow, concrete can wedge or arch itself across the top of the narrow space and cause cracks.</p>
	<p>Plastic settlement cracks are those developed by definite changes of section such as the cracking below column head.</p>
	<p>The changes in a section of trough and waffle floor slabs cause more settlement in the webs than in the relatively thin flanges eventually result in cracking.</p>
	<p>When the sub-base or other material placed against the concrete is very absorbent i.e. dry soil or absorbent formwork, exaggerated type of plastic settlement cracks are likely to develop. In such situation the cracks will generally follow the reinforcement pattern and run parallel to each other.</p>

Table 01.

## WHY DO PLASTIC SETTLEMENT CRACKS OCCURRED ?

- Volume reduction in the cement-water system caused by high flowable concrete (High Slump/Flow) leads to segregation and bleeding with high efforts of vibration. (Figure 03.)
- Internal confinement from large-size aggregates or reinforcement steel.
- External confinement from relatively narrow formwork.
- Significant changes in the concrete cross-section.
- Absorbent sub-base or formwork surface.
- Flared column heads, troughs, and waffles in floor slabs.
- Settlement or bulging of the formwork and supporting system.

These factors, either individually or in combination, can lead to cracking in concrete.

## SUMMARY OF PLASTIC SETTLEMENT CRACKS IN CONCRETE

SUMMARY OF PLASTIC SETTLEMENT CRACKS IN FRESH CONCRETE	
Time of Appearance	<ul style="list-style-type: none"> <li>• 10 to 180 minutes</li> </ul>
Types / Locations	<ul style="list-style-type: none"> <li>• Over form work the bolts, or over reinforcement near the top of section.</li> <li>• In narrow column and walls due to obstacles to sedimentation by resulting arching action of concrete due to narrow passage.</li> <li>• At change of depth of section.</li> <li>• Arching on top of columns</li> </ul>
Primary Causes	<ul style="list-style-type: none"> <li>• High flow concrete mix</li> <li>• Excess bleeding</li> <li>• Over vibration</li> </ul>
Secondary Causes	<ul style="list-style-type: none"> <li>• Rapid Early Drying Conditions</li> <li>1. High ambient temperatures / Hot Sun</li> <li>2. Low Humidity</li> <li>3. High Wind Velocity</li> </ul>
Preventive Measures	<ul style="list-style-type: none"> <li>• Increase finer fines in the fine aggregates and cohesiveness of concrete mix</li> <li>• Match the vibration efforts with mix flow</li> <li>• Use air entrainment</li> <li>• Do re-vibration for proper compaction</li> </ul>

Table 02.

## HOW TO MINIMIZE PLASTIC SETTLEMENT CRACKS?

### Concrete:

- Select mixes with lower bleeding characteristics, such as lower slump and more cohesive mixes. Accordingly, when using high-slump or flowable concrete essential and a matter, precaution action shall be taken to minimize vibration efforts to prevent segregation and bleeding, which can lead to plastic settlement cracks.
- Increase the ratio of concrete cover to reinforcing bar diameter by either increasing the cover or decreasing the size of the bars.
- While avoiding the use of retarding admixtures is sometimes recommended to minimize plastic settlement cracking, in hot weather, the benefits of their use outweigh the disadvantages.

### Construction:

- Make all required measures to minimize the evaporation rate from concrete surface, especially from the first 10 hours. (Please refer to CONMIX Technical Article No. 001)
- Use skilled workers and tools of appropriate capacity to manage and control vibration during concrete work.

- Ensure all formwork is accurately set and rigid to prevent movement during concrete placement.
- Ensure that all steel reinforcement is set, rigid and totally fixed to prevent movement of steel under manpower during the plastic stage.
- Start by placing concrete in deep sections, including columns, allowing it to settle before placing and compacting the top layers to ensure a seamless blend.
- Thoroughly compact the concrete.
- Promptly and properly cure the concrete.
- Pre-wet the subgrade before pouring concrete to prevent excessive water loss from the base.

## **REPAIR OF PLASTIC SETTLEMENT CRACKS**

### **• In pre-hardened concrete (Plastic Stage):**

The most efficient repair method is to promptly address the cracks by re-vibrating and reworking the surface while the concrete is still in its plastic state. Timing is crucial to ensure that the concrete re-liquefies under the vibrator's action, fully closing the cracks. Usually, the cracks appear from 30 minutes till 4 hours of placement time.

### **• In hardened concrete:**

Once the concrete has hardened, it is possible to chase out and fill plastic settlement cracks using an appropriate proprietary material. It is challenging to conceal plastic settlement cracking completely; the goal is to maintain the durability and wear characteristics of the surface.

## **CONCLUSION**

Engineers need a comprehensive understanding of the causes of cracking during concrete casting to minimize cracks after construction and hardening.

Cracks are common in all concrete structures and are generally unavoidable. However, they can be minimized through careful design, construction practices, and procedures. While cracks in fresh concrete (plastic settlement) are not usually a cause for concern, they should be promptly controlled and repaired to prevent long-term durability issues in the structure.



## References

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By \_\_\_\_\_

**Abdalmenem M.A. Al Namoor**

Civil Engineer, NRMCA—CCPf / PMP



[conmix.com](http://conmix.com)



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