7(a). Define shrinkage and creep of concrete. Discuss the different factors affecting shrinkage of concrete.

Ans = Shrinkage and creep are two important phenomena associated with concrete that occur over time.

1. Shrinkage:
Shrinkage refers to the decrease in volume or dimension of hardened concrete due to the loss of moisture. As concrete cures and dries, water evaporates from the paste, leading to a reduction in volume. Shrinkage can occur both in the plastic state (during the drying and hardening process) and in the hardened state (after the concrete has fully cured). There are primarily three types of shrinkage in concrete:

- Plastic Shrinkage: Plastic shrinkage occurs during the early stages of concrete curing when water evaporates from the surface faster than it can be replaced. This can result in surface cracking and is more common in hot and dry conditions.

- Drying Shrinkage: Drying shrinkage happens as the moisture content in the concrete decreases over time. It occurs due to the capillary water within the concrete evaporating, causing the solid materials to contract. Drying shrinkage is influenced by factors such as the water-cement ratio, aggregate properties, cement content, and environmental conditions.

- Autogenous Shrinkage: Autogenous shrinkage is a self-desiccation process

that occurs in the absence of external drying. It is caused by the chemical reactions taking place during cement hydration, resulting in the loss of water. Autogenous shrinkage is influenced by factors such as cement type, fineness, temperature, and mix proportions.

Factors affecting shrinkage of concrete include:
- Water-Cement Ratio: A higher water-cement ratio typically results in higher shrinkage due to the excess water available for evaporation.
- Aggregate Type and Proportion: Different types of aggregates can influence shrinkage. For example, aggregates with high absorption capacity can contribute to higher shrinkage.
- Cement Type: The type of cement used can affect shrinkage. For instance, cement with a higher sulfate content tends to have greater shrinkage.
- Curing Conditions: Proper curing can help reduce shrinkage by maintaining moisture levels in the concrete. Inadequate or improper curing can lead to increased shrinkage.
- Temperature and Humidity: High temperatures and low humidity can accelerate the drying process and increase shrinkage. Conversely, lower temperatures and higher humidity can help mitigate shrinkage.

2. Creep:

Creep is the time-dependent deformation or flow of concrete under sustained loading. When concrete is subjected to continuous stress, it gradually undergoes deformation over time. Creep can occur due to the viscoelastic nature of the cement paste, which allows the concrete to slowly deform under stress. Creep is primarily influenced by the following factors:

- Stress Level: Higher stress levels lead to greater creep deformation. Creep is more significant at higher sustained loads.

- Time: Creep deformation continues to occur over an extended period. It is a function of time, and the creep rate gradually decreases over time.

- Age of Concrete: Creep is more significant in early-age concrete, and its magnitude reduces as the concrete matures.

- Aggregate Type and Proportion: Different types of aggregates can affect creep. Aggregates with high elastic modulus can help reduce creep deformation.

- Humidity and Temperature: Higher humidity and lower temperatures tend to reduce creep. Moist curing or exposure to a higher relative humidity environment can decrease the creep of concrete.

Understanding the factors affecting shrinkage and creep is essential for proper concrete mix design, structural analysis, and long-term performance prediction of concrete structures. By considering these factors, engineers can design and construct durable and reliable concrete elements.