

1. The theoretical basis for producing high-strength concrete (HSC) was originally developed in the field of ceramic materials in the late 1950s and early 1960s. Based on single-phase polycrystalline ceramic materials, it was shown that reduced particle dimension increased the strength. The dependence of the particle size on the strength was explained on the basis of Griffith's theory for the rupture of brittle materials with internal cracks. In accordance with this theory the strength of the material should increase with decreasing pore and particle size by a square root law. Later on, it was shown that there was a similar relationship between microstructure and strength for cement pastes with densely packed cement particles at a very low water/ cement ratio. However, it was not until the early 1970s that new and very effective agents for dispersing the fine cement particles in water became available, and then, a tremendous advance in the production of high-quality concrete was achieved.

At the same time, large quantities of ultrafine condensed silica fume particles also became available. Therefore a commercial basis for production of concrete with very high density and strength was established, and a rapid development of HSC took place. Since a low-porosity concrete with high density will also enhance the overall performance of the material, the term "high-performance concrete" (HPC) was also soon introduced, which is inclusive of the term "HSC." More and more, however, the term "HPC" was mostly used and specified for concrete durability rather than for concrete strength. In the literature, there are a number of definitions of both "HSC" and "HPC," but as properly discussed by Ai'tcin in his book on HPC (Ai'tcin, 1998), there is no clear consensus about the meaning of either of these terms. In the literature, some people try to define HSC as different from "normal strength concrete," "ordinary concrete," or "usual concrete," but what is "normal," "ordinary," or "usual" is rapidly changing. Also, some definitions are based on a maximum water/cement ratio, but nor is the term "water/cement ratio" easy to define any longer. For many years, when concrete was mostly based on pure Portland cement and simple procedures for concrete production, the concept of water/cement ratio was the fundamental basis for characterizing concrete quality.

Since a number of different cementitious materials and reactive fillers are now being used for concrete production, the concrete properties are more and more being controlled by various combinations of such materials. In addition, the concrete properties are also increasingly being controlled by the use of various types of processed concrete aggregate, new concrete admixtures, and sophisticated production equipment. Therefore the old and very simple terms "water/cement" or "water/ binder ratio" for characterizing concrete quality successively lost their meaning. As a consequence, performance definition and specification for concrete quality based on performance criteria are more commonly being applied. In order to stimulate the use of HPC for highway applications in the United States,

the Federal Highway Administration in the early 1990s defined HPC by four durability and four strength parameters, which are as follows (Goodspeed, Vanikar, & Cook, 1996):

Durability	Strength
<ul style="list-style-type: none"><li>• freeze/thaw durability</li><li>• scaling resistance</li><li>• abrasion resistance</li><li>• chloride permeability</li></ul>	<ul style="list-style-type: none"><li>• compressive strength</li><li>• elasticity</li><li>• shrinkage</li><li>• creep</li></ul>

Based on the requirements for each parameter, four different performance grades were defined, and details of test methods for determining the performance grades given. Then, the applications of the various HPC grades for various exposure conditions were recommended.

High-strength concrete (HSC) is a type of concrete that is designed to possess enhanced compressive strength compared to traditional concrete mixes. It typically has a compressive strength greater than 6,000 psi (41 MPa). The increased strength of high-strength concrete allows for the construction of structures that can withstand heavier loads and exhibit improved durability. Here are some key points about high-strength concrete:

**Mix design:** High-strength concrete requires careful consideration of the mix design, which involves selecting suitable proportions of cement, aggregates, water, and sometimes additional chemical admixtures. The mix design aims to optimize the particle packing and the water-to-cement ratio to achieve the desired strength.

**Cementitious materials:** High-strength concrete often incorporates a higher proportion of cementitious materials, such as Portland cement, fly ash, silica fume, or slag cement. These materials enhance the hydration process and contribute to the strength development of the concrete.

**Aggregates:** The selection of aggregates is crucial in high-strength concrete. Well-graded, high-quality aggregates with a low water absorption rate are preferred to ensure optimal particle packing and reduce the potential for weak points in the concrete matrix.

**Water-to-cement ratio:** High-strength concrete typically has a low water-to-cement ratio, which minimizes the water content while maintaining the workability of the mixture. A low water-to-cement ratio improves the density and strength of the concrete by reducing the porosity and enhancing the cement hydration.

**Admixtures:** Chemical admixtures are often used in high-strength concrete to improve workability, reduce water content, control setting time, and enhance the overall

performance of the concrete. Superplasticizers, for example, are commonly added to increase the fluidity of the mixture without compromising its strength.

Curing: Proper curing is critical for the development of strength in high-strength concrete. Curing methods such as moist curing or the application of curing compounds or membranes help prevent moisture loss and maintain favorable conditions for the hydration process.

Applications: High-strength concrete finds applications in various construction projects, including high-rise buildings, bridges, dams, nuclear power plants, offshore structures, and precast concrete elements. Its increased strength allows for the design of slimmer and more efficient structural elements.

It's important to note that working with high-strength concrete requires expertise and careful consideration of various factors, including mix design, materials, and curing methods. Consulting with a structural engineer or concrete expert is recommended when working with high-strength concrete to ensure its proper application and performance.

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3. The history of steel bars can be traced back thousands of years to ancient civilizations that sought to improve their metalworking techniques. However, I will provide a condensed overview of the key milestones in the development of steel bars.

For Instance, Ancient Times: The production of iron, a crucial precursor to steel, dates back to around 1800 BCE. Early civilizations, such as the Hittites and Egyptians, began to smelt iron ore and shape it into various tools and weapons. Iron bars were forged by heating and hammering the metal, resulting in stronger and more durable implements. In the late 19th and early 20th centuries, further innovations revolutionized steel production. The open-hearth process, introduced in the 1860s, allowed for greater control over the composition of steel. Later, the introduction of the basic oxygen process in the 1950s further improved steelmaking efficiency.

Steel Bar Applications: Steel bars have been indispensable in various industries, including construction, infrastructure, manufacturing, and transportation. They are used in reinforced concrete structures, bridges, high-rise buildings, machinery, automotive components, and more. The versatility and strength of steel bars have made them a vital material in modern society.

Today, steel bars continue to be widely produced and utilized worldwide. The manufacturing processes have become highly advanced, incorporating techniques like electric arc furnaces and continuous casting to produce high-quality steel bars with precise specifications.

A steel bar, commonly known as a reinforcement bar or rebar, is a type of steel product used as a tension device in reinforced concrete structures. It is essential for providing strength, durability, and structural integrity to concrete elements.

Steel bars are embedded in concrete structures to increase their tensile strength and improve resistance to cracking. Concrete is strong in compression but weak in tension. By incorporating steel bars, the composite material formed (reinforced concrete) can withstand tensile forces, preventing cracking and enhancing the overall strength and performance of the structure.

Steel bars used in reinforced concrete can be categorized into two main types: deformed bars and plain bars. Deformed bars have ribbed surfaces, which provide better bonding between the steel and concrete, improving the load transfer capacity. Plain bars, on the other hand, have a smooth surface and are primarily used in specific applications where bonding with concrete is not a requirement.

The selection and use of steel bars in concrete construction follow specific standards and codes. In many countries, the most commonly adopted standard for steel reinforcement is provided by the American Concrete Institute (ACI) or the British Standards Institution (BS). These standards outline the specifications, grades, and properties of steel reinforcement for different structural applications.

Steel bars, commonly referred to as reinforcement bars or rebars, are frequently used in construction to reinforce concrete structures, including those located below the soil. Here are a few ways steel bars can be utilized under the soil:

**Foundation Footings:** In building construction, steel bars are often placed within the concrete footings of a foundation. These footings serve as the base of a structure and are positioned beneath the ground level. The steel bars provide tensile strength to the concrete, making it more resistant to cracking and structural failure.

**Pile Foundations:** Piles are long cylindrical structures made of concrete or steel that are driven deep into the ground to provide support for buildings and other structures. Steel bars are frequently used in the construction of steel piles. These bars may be placed vertically within the pile or spiral around the circumference to enhance its load-bearing capacity and structural integrity.

**Reinforced Earth Structures:** Reinforced earth structures, such as retaining walls and bridge abutments, use a combination of soil and geosynthetic materials. In such structures, steel bars or strips can be inserted horizontally into the soil or geosynthetic layers to provide reinforcement and increase stability.

**Underground Structures:** Steel bars are also utilized in various underground structures, such as tunnels and underground parking lots. These bars are typically arranged in a grid pattern and embedded within the concrete to enhance the overall strength and durability of the structure. They help distribute loads and resist the pressures exerted by the surrounding soil.

**Retaining Walls:** Retaining walls are structures built to hold back soil and prevent erosion. Steel bars can be incorporated into the concrete retaining wall to increase its strength and stability. The bars are typically placed horizontally and vertically within the wall to reinforce it and minimize the risk of collapse.

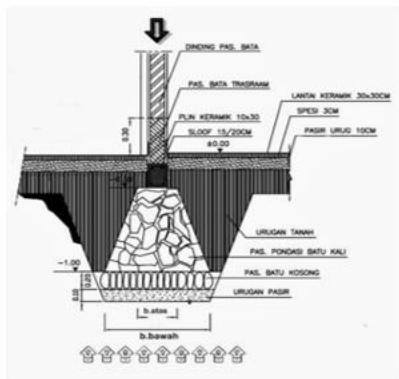
These are drawing details of steel bar that being used in foundation concrete:



**Pile Cap**



**Sloof**



**Track pile**



**Bor Pile**

When using steel bars in foundation concrete, there are several challenges that can arise. Some of the common challenges include:

**Corrosion:** Steel bars are susceptible to corrosion when exposed to moisture and certain chemicals present in the soil. Corrosion can weaken the steel bars over time, leading to structural integrity issues. Adequate measures, such as proper concrete cover and the use of corrosion-resistant coatings or stainless steel reinforcement, can help mitigate this challenge.

**Bonding with concrete:** Steel bars need to form a strong bond with the surrounding concrete to ensure effective load transfer. However, factors such as improper surface preparation, insufficient overlap between bars, or the presence of contaminants can hinder the bond between the steel and concrete. This can compromise the structural strength of the foundation.

Thermal expansion and contraction: Steel has a higher coefficient of thermal expansion compared to concrete. This means that during temperature variations, steel bars expand and contract more than the surrounding concrete. If not accounted for, this differential movement can lead to cracking and structural problems in the foundation.

Placement and positioning: Proper placement and positioning of steel bars within the concrete are crucial for ensuring structural strength. Challenges may arise during the construction process, such as difficulty in achieving the desired spacing, proper alignment, or maintaining the required concrete cover over the steel bars. Any inconsistencies in placement can affect the overall performance of the foundation.

Compatibility with concrete: Steel bars and concrete have different properties, including their tensile and compressive strengths. It is important to ensure that the steel reinforcement used is compatible with the concrete mix design and structural requirements. Failure to consider this compatibility can result in uneven stress distribution, compromising the overall integrity of the foundation.

Construction site conditions: The construction site environment can also pose challenges when using steel bars in foundation concrete. Factors such as limited accessibility, presence of groundwater, poor soil conditions, or exposure to extreme weather conditions can make the placement and installation of steel reinforcement more difficult and can impact its performance.

To overcome these challenges, it is important to follow proper engineering and construction practices, employ skilled labor, and adhere to relevant building codes and standards. Regular inspections, quality control measures, and ongoing maintenance can also help address these challenges and ensure the long-term durability and stability of the foundation.

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