

Vanadium vs. Niobium in Rebar

Any microalloying element used in high strength rebar must offer users combinations of high strength, good ductility, bendability, ease of welding, mechanical joining and insensitivity to strain ageing.

Solubility of Microalloying Elements

To be most effective, microalloying elements must be in solution prior to the start of rolling. At a typical reheating temperature of 1150°C:

Vanadium Carbonitrides



This is enough to dissolve all of the vanadium.

Niobium Carbonitrides



The niobium would have not fully dissolved.

Most of the vanadium is retained in solution prior to and during rolling, which allows for producers to roll many different shapes and sizes without any difficulty. With vanadium, full microalloying potential can be utilized and the property variations and/or bowing of the bars on the cooling bed due to the non-uniform solubility that occurs with niobium can be avoided.

Hot Ductility

Refers to a structure's ability to undergo large deformation without breaking in a brittle and abrupt manner.



Vanadium



Relatively high ductility over a wide temperature range, thus vanadium steel is less prone to cracking during continuous casting.

Niobium



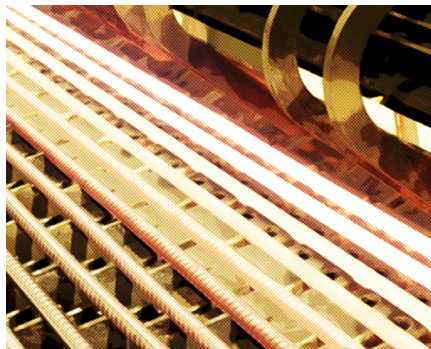
Lower ductility during casting than vanadium steels, therefore more likely to crack during casting.



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Hot Rolling

High finishing temperatures are achieved during rolling to increase productivity and help producers achieve the required shape and size.



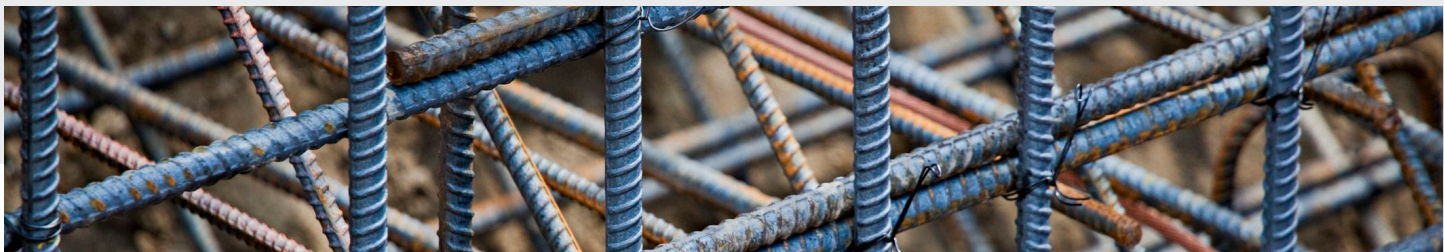
Vanadium ✓	Niobium ✗
Vanadium remains in solution during rolling and has little influence on recrystallisation resulting in low rolling loads.	Niobium results in increased rolling loads. The low rolling temperatures typically used for niobium steels to improve properties are not achieved during rebar rolling.

Vanadium containing steels result in lower rolling loads than niobium containing steels.

Microstructure

For rebar to achieve the desired levels of strength, ductility and toughness, the microstructure must be fine grained and free from hard phases such as bainite and martensite.

Vanadium ✓	Niobium ✗
Vanadium additions result in a ferrite pearlite microstructure with no hard brittle phases.	Niobium adds hardenability which may result in bainite formation during cooling, resulting in poor bendability and lower toughness. The grain refinement usually associated with niobium cannot be achieved due to the high rolling temperatures normally associated with rebar production.



Increased Strength

Microalloying elements have the potential to increase strength by introducing carbonitride particles. To be effective strengtheners, these particles must be ultra-fine and present in sufficient numbers.

Vanadium ✓	Niobium ✗
Large numbers of fine vanadium carbonitride particles allow for large increases in strength to be obtained.	Due to the low solubility of niobium, few fine niobium carbonitrides can be produced and hence the potential for increased strength is limited.