

Super High Strength Valve Spring Steel with Excellent Fatigue and Sag Resistance

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Valve springs for automobiles are subject to high repeated loads and are required to be reliable for a long period of time. To improve fuel consumption and to downsize engines, valve springs are designed for higher stress and, thus, there is a need for spring steels having higher fatigue strengths. Kobe Steel developed a super high strength steel having higher fatigue strength and sag resistance, compared to those of conventional high strength steel (KHV10N).

Features

The design concept and the main features of the developed steel are as follows.

- 1) Fatigue strength was improved by the alloy composition optimized for nitriding.
 - The increased contents of Cr and V, which increase the surface hardness and residual stress after nitriding, improved the fatigue strength.
- 2) The sag resistance was improved by the super-fine grain and increased softening resistance of the oil tempered wire.
 - The increased contents of Si, Cr and V improve the softening resistance so that the spring strength (internal hardness) does not decrease during the stress relief annealing and high temperature nitriding after spring forming.
 - The increased V content, along with an optimized heat treatment, produces super fine grains, improving both the sag resistance and the toughness of the high strength region.
- 3) A new method for controlling the compositions of inclusions has decreased deleterious non-metallic inclusions which may cause fatigue fracture. The reliability of springs was thus improved.

Properties

The developed steel exhibits the highest strength among our high strength valve spring steels. Its fatigue strength is about 10% higher than that of KHV10N (**Figure 1**). The residual shear strain (sag amount) is reduced to about 2/3 of that of conventional steel (**Figure 2**).

The developed steel reduces the weight of a spring by 13% and the height by 8% (**Figure 3**) compared to the conventional KHV10N, contributing to weight reductions, downsizing and improved performance of valve trains. The steel enables engines to rotate at higher speeds while reducing fuel consumptions.

Applications

The developed steel is applicable to high strength valve springs and other parts, such as clutch springs, in which high fatigue strength and sag resistance are required.

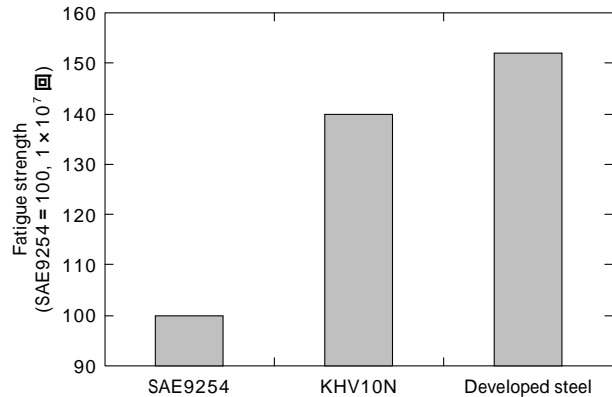


Fig. 1 Fatigue strength

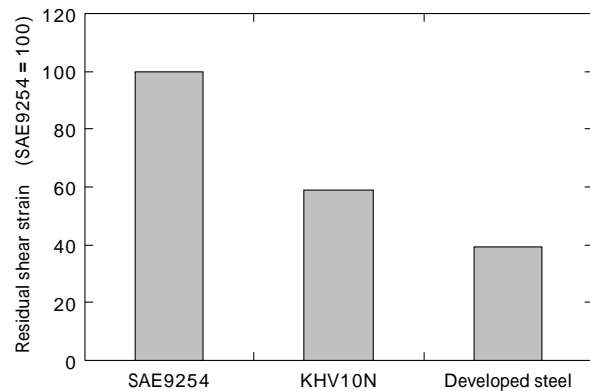


Fig. 2 Residual shear strain

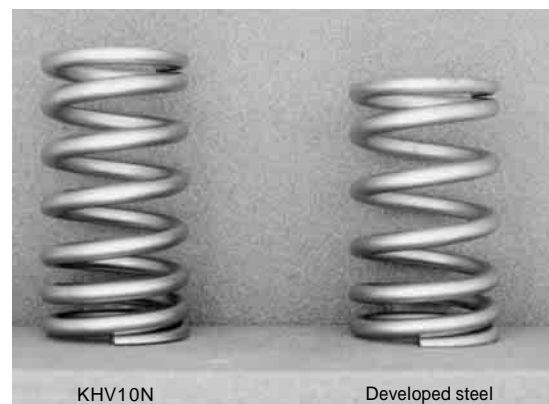


Fig. 3 Application example of developed steel