# Novel Alloying Design for Press Hardening Steels With Better Crash Performance

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## ABSTRACT

Over the last decade the press-hardening process has become a key lightweight technology for the automotive industry worldwide because it offers ultra-high strength up to 1500MPa for the safety components; adopts the modern manufacturing technology to form the ultra-high strength steels and finally gives carmakers new opportunities to achieve the lightweight design. Today's state-of-the-art designs utilize up to 26% of press-hardening steels in the car body and up to 40% use is projected in future vehicle designs.
However the alloying concept of the standard press hardening steel 22MnB5 was not originally designed for automotive application. Due to the martensitic microstructure and the high strength level the crash performance of press hardening steel is highly dependent on its toughness, bendability (3-point-bending test) and resistance to delayed hydrogen induced cracking. Based on this consideration the potential problems of the conventional alloying concept will be discussed and some latest research results, which are related to the improvement of press hardening steels for a better crash performance, will be presented. Finally this paper will introduce the novel alloying designs for high strength steels, which are tailored for press hardening process and suitable for automotive application. The key of the new alloying concept is to adopt Nb microalloying and to modify the remaining alloy composition as to get final properties that are better matching the needs of automotive application and still allow stable or even improved manufacturing in the press shop.

## INTRODUCTION

Over the last decade press hardening technology has developed very fast worldwide and press-hardening steel has been widely used in the car body structure for high safety standard and lightweight achievement. According to the estimation currently there are about 190 production lines worldwide with a total capacity of 285 million components per year. In some 2012 European car models (Audi A3 [1], Volvo V40 [2]) press hardening steel has reached a share of more than 20% of the body-in-white weight. In the future press hardening steel will continue to gain a greater share, as weight reduction of the car body remains a priority. According to estimation by Volvo, PHS could reach a weight contribution of 40% in car body application [2]. With such a high share of PHS, car bodies approach the weight of an equivalent full aluminum body, yet at significantly lower cost.

### Is Mn-B steel the optimum alloying concept for automotive applications?

Contrary to the development of press hardening process technology the most widely used press hardening steel 22MnB5 has practically remained unchanged since its origin in the 1970's and the metallurgical concept has never been under discussion. 22MnB5 belongs to boron steels (EN 10083-3), which were originally developed to make low-cost wear resistant components used e.g. in agricultural equipment. The hardenability during the quenching process is most important especially as such components have an increased gage. Besides of carbon, manganese and chromium (in fewer cases molybdenum), boron is especially alloyed to increase the hardenability. Solute boron when segregated to the austenite grain boundary before quenching impedes the nucleation of proeutectoid ferrite and thus promotes the formation of harder phases such as bainite and martensite. Carbon, manganese, chromium and molybdenum have the effect of lowering the bainite start temperature [3]