

## Durability Analysis of a Knuckle Arm Using VPG System

**Authors :** Geun-Yeon Kim, S. P. Praveen Kumar, Kwon-Hee Lee

**Abstract :** A steering knuckle arm is the component that connects the steering system and suspension system. The structural performances such as stiffness, strength, and durability are considered in its design process. The former study suggested the lightweight design of a knuckle arm considering the structural performances and using the metamodel-based optimization. The six shape design variables were defined, and the optimum design was calculated by applying the kriging interpolation method. The finite element method was utilized to predict the structural responses. The suggested knuckle was made of the aluminum Al6082, and its weight was reduced about 60% in comparison with the base steel knuckle, satisfying the design requirements. Then, we investigated its manufacturability by performing forging analysis. The forging was done as hot process, and the product was made through two-step forging. As a final step of its developing process, the durability is investigated by using the flexible dynamic analysis software, LS-DYNA and the pre and post processor, eta/VPG. Generally, a car make does not provide all the information with the part manufacturer. Thus, the part manufacturer has a limit in predicting the durability performance with the unit of full car. The eta/VPG has the libraries of suspension, tire, and road, which are commonly used parts. That makes a full car modeling. First, the full car is modeled by referencing the following information; Overall Length: 3,595mm, Overall Width: 1,595mm, CVW (Curve Vehicle Weight): 910kg, Front Suspension: MacPherson Strut, Rear Suspension: Torsion Beam Axle, Tire: 235/65R17. Second, the road is selected as the cobblestone. The road condition of the cobblestone is almost 10 times more severe than that of usual paved road. Third, the dynamic finite element analysis using the LS-DYNA is performed to predict the durability performance of the suggested knuckle arm. The life of the suggested knuckle arm is calculated as 350,000km, which satisfies the design requirement set up by the part manufacturer. In this study, the overall design process of a knuckle arm is suggested, and it can be seen that the developed knuckle arm satisfies the design requirement of the durability with the unit of full car. The VPG analysis is successfully performed even though it does not an exact prediction since the full car model is very rough one. Thus, this approach can be used effectively when the detail to full car is not given.

**Keywords :** knuckle arm, structural optimization, Metamodel, forging, durability, VPG (Virtual Proving Ground)

**Conference Title :** ICAME 2015 : International Conference on Automotive and Mechanical Engineering

**Conference Location :** Paris, France

**Conference Dates :** February 23-24, 2015