SHAPE OPTIMISATION OF RAILWAY WHEEL PROFILE

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Summary The paper presents a procedure for optimal design of a wheel profile based on geometrical wheel/rail contact characteristics. An optimized wheel profile is obtained as a solution of inverse (minimization) problem. A number of new wheel profiles are obtained. Their advantage compared with old one is shown.
Keywords: Inverse problems, shape optimisation, wheel-rail contact, multipoint approximations

INTRODUCTION

A rolling radii difference is one of the main characteristics that describes a contact between wheelset and railway track, which in turn defines the dynamic behaviour of a wheelset [[1], [2]]. Generally, it is a non-linear function of the lateral displacement y of wheelset. Due to the wear of wheels the wheel profile and consequently Δr are changing as shown in Figure 1. Determination of '$y-\Delta r$' curve for given wheel and rail profiles is a well-known problem, which is out of scope of this paper. A more interesting problem is solution of the inverse problem, i.e. determination of a wheel profile for a given rail, which has an a priori defined rolling radii difference Δr (Figure 3).

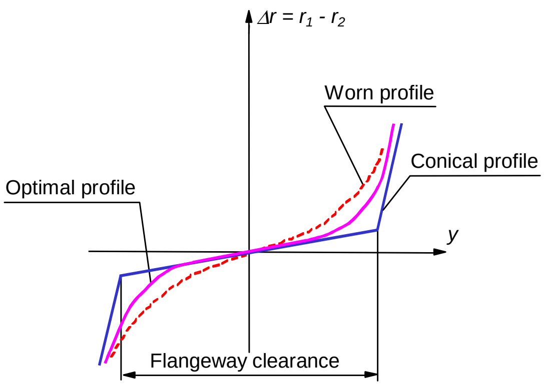

Figure 1 Rolling radii difference vs. lateral displacement of wheelset curve ('$y-\Delta r$'curve)

PROBLEM FORMULATION

Solution of such inverse problem is formulated here as a minimization problem. A shape of a wheel profile is varied in order to minimize the difference between the calculated and given rolling radii difference of a wheelset. The shape of the wheel profile is approximated by a Piecewise Cubic Hermite Interpolating Polynomial. The shape of the wheel profile has been varied by changing position of some points of the profile as shown in Figure 2. The minimization is performed subject to geometrical constrains in order to prevent unrealistic profiles. A solution of the minimization problem is taken as a new wheel profile. Wheels with such a profile have a given contact characteristics, which results in improved wheelset dynamics and in reduction of wheel flange wear.

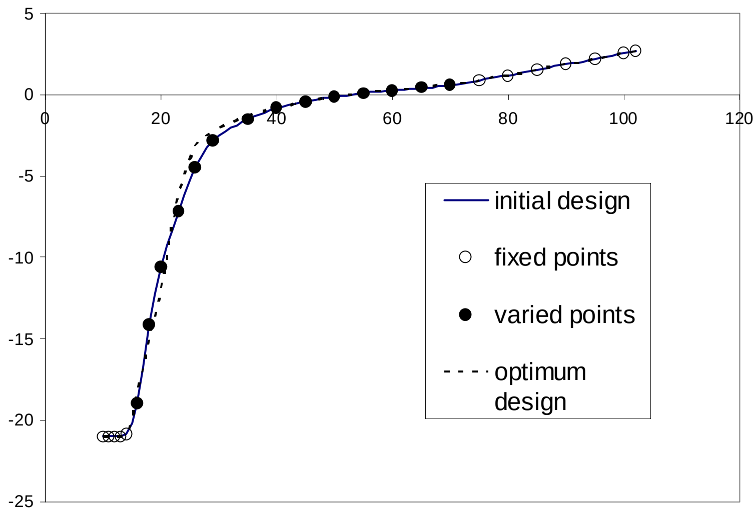

Figure 2 Design variables, initial and optimum shape of a wheel

RESULTS

The problem has been solved using the MARS method (Multipoint Approximation based on Response Surface fitting) [[3]], [[4]]. The method has been specifically developed for problems where multiple response analyses and (time consuming) simulations are involved.

Using the presented procedure a new wheel profile for a tram has been obtained. The dynamic behavior of vehicles with new and original wheel profiles has been analyzed and compared using ADAMS/Rail. The results of optimisation (Figure 2 and Figure 3) are presented and discussed in the full paper.

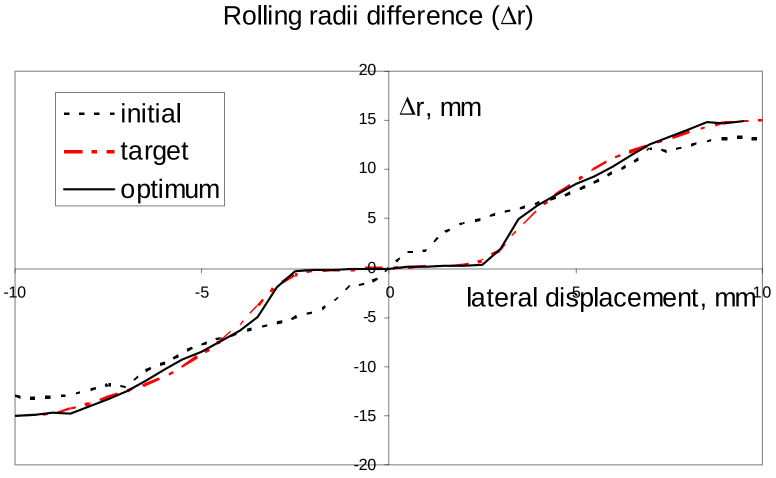

Figure 3 Results of optimisation: target rolling radii difference and the ones for initial and obtained wheel profiles

References

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