

Background to master thesis: *Process induced prestress losses in long bed systems for railway sleepers*

Introduction

Abetong has produced prestressed concrete sleepers for the Swedish railway since the middle of 1960's. The production method used is developed by Abetong and called the long line method. The principal of the method is that long beds (about 100 m) with quadruple sleeper moulds placed after each other is used in order to get a rational production with low labour cost for each sleeper. The method will also result in a high quality product with a very low rejection rate.

The method has proven to be successful and is currently used on a licensee basis in 35 sleeper plants around the world.

A typical view from inside a sleeper plant with the machinery and long beds of Abetong is shown in Figure 1.



Figure 1 Typical view from inside a sleeper plant using the production method of Abetong

Background

The capacity requirements of the railways around the world are constantly increasing in terms of axle load and train speed. This will increase the bending moment requirements of the sleepers. Monoblock sleepers used today utilise prestressed reinforcement in order to meet the requirements set in the sleeper specifications and standards.

The prestress applied to a sleeper will provide almost half of the crack initiation capacity of the sleeper, which is one of the most important requirements in the sleeper specification. Optimisation of

the sleeper design will force the manufacturers to have in depth knowledge of all influencing parameters active during the production of a sleeper in order to provide a safe and economical product.

Abetong has done extensive measurements in the production during the last years in order to identify the parameters influencing the prestress losses that occurs both during the production and afterwards [1,2]. It has been proven that the general guidelines given in Eurocode calculating prestress losses in concrete members is not fully applicable to prestressed concrete sleepers due to its slender geometry in combination with the relatively high prestress level (400-500kN). Full understanding of the given prestress losses when producing sleepers with a long bed system is hence needed.

Aim and Scope

The aim with the master thesis is to establish a FE-model of an entire bed at an appropriate detail level which allows us to obtain the same results as has been given from the measurements during the production. The evaluation of the measuring results has given strong indication that the temperature increase in the hydrating concrete in combination with the restraints given by the active and passive end of the bed has a large influence to the prestress losses given during the production of the sleepers.

The measurements has also shown that the prestress losses could vary along the bed due to effects given by stepwise bonding along the bed given by the 30-90 minute casting process along the entire bed.

The analysis should include an initial heat flow analysis that creates the strain field that should be applied in a structural analysis. A simplified model has been established in DIANA by Abetong and this model could serve as a platform for further improvements.

In the occasion of a need of additional measurements in order to prove the behaviour of the model or to get more input to the model Abetong will provide the opportunity to conduct these measurements in the sleeper plant placed in Vislanda (20 km from Växjö where the HQ of Abetong is placed).

Identification of mechanisms present during the production process

So far, the results from the measurements done by Abetong has been used trying to understand and identify the mechanisms present during the different phases of the production process. A summary of these interpretations are given in Figure 2 below. Hopefully, the simulations that is done within the thesis will be able to confirm the interpretations done or improve the understanding leading to other interpretations.

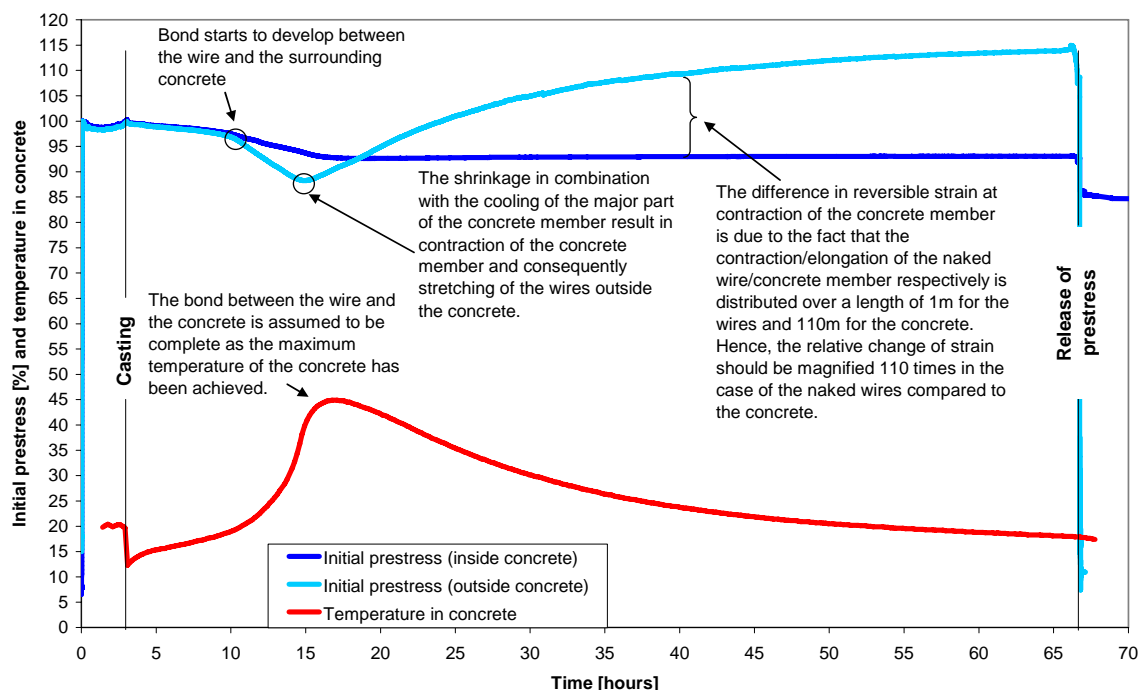


Figure 2 A summary of the mechanisms that is interpret to be present at different stages of the curing.

Prerequisites of the master thesis

The thesis report should be written in English and include all vital findings presented in a clear and logical way. Abetong promote that the thesis is done by two students but we can also allow the work to be done by one student.

The reason for Abetong to launch this thesis is that the topic is of vital interest and the time needed in order to penetrate all aspect of the topic is not really at hand in the everyday work. Rikard Bolmsvik working with all design aspects of sleepers within Abetong will provide all needed information and support from Abetong. Rikard did his PhD at Structural Engineering and presented his PhD-thesis "Structural Behaviour of Concrete Railway Sleepers" in 2002.

The thesis should be finalised until June 2011 as Abetong intend to present results from the work at the Abetong licensee symposium in Vilnius at the beginning of June 2011.

References

1. Internal report, M Jansson, Status of prestressed concrete sleepers after 7-38 years of service life -An empirical and theoretical investigation of the ageing of sleepers, 2010.
2. Internal report, Measuring campaign, prestress losses in Vislanda, 2011.