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Doctoral Programme in Conservation

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Title:

TARRING MAINTENANCE OF NORWEGIAN MEDIEVAL STAVE CHURCHES

Characterisation of pine tar during kiln-production, experimental coating procedures and weathering

Abstract

A principal statement issued by Norway's cultural heritage authorities defines the starting point for the present dissertation. This statement declares that tar which is produced by traditional methods (i.e. kiln-produced tar using resinous heartwood of stumps of Scots pine -*Pinus sylvestris* L.) should be used in connection with the maintenance of medieval wooden stave churches, since this material is assumed by the authorities to be the authentic coating material. This assumption regarding the material has been further substantiated by this dissertation. The stipulated desire for the use of authentic materials and techniques in architectural conservation is presented and discussed, and particularly whether this desire is, and should be, consistently carried out where stave churches are concerned.

Even though proper kiln-produced tar has been used during the course of the last two decades at least, the situation regarding the maintenance of the tarred exteriors is nonetheless not satisfactory. Consequently, one of the main aims of this study was to gather knowledge by means of conducting tarring experiments in order to improve this maintenance situation. Traditional modifications or pre-treatments of the tar, such as boiling, have been tested. Since kiln-produced tar is extracted successively from the kiln into barrels, a systematic distinction between tar grades, or tar fractions, has been made, and they have been compared in experiments.

In order to distinguish between complex pine tar samples of great compositional similarity, a suitable chemical analytical technique had to be applied. In this instance gas chromatography-mass spectrometry (GC-MS) was selected. The pine tar samples have been analysed during the course of production, boiling, following application on test panels, and at intervals during accelerated and natural weathering. It is demonstrated that a significant distinction between newly produced tar samples from a kiln can be made by GC-MS analysis. Further analytical evidence established that boiling of the tar below 200°C does not result in greater similarities between the tar grades. Even after 30 months of weathering, it is still possible to distinguish between tar samples originating from different barrels deriving from the same kiln production.

On the basis of visual assessment, the experiments demonstrated that the more comprehensively the tar was seethed, the greater the improvement in resistance to weathering. It was also shown that, when exposed on the sunniest side, tar deriving from the first part of the production process exhibited better resistance to weathering than tar from the last part of the process. Both the seething of tar and the distinction of tar grades consequently provide potential for improvement in tarring results.

Keywords:

Pine tar, pitch, wood tar, *Pinus sylvestris*, lightwood, resinous wood, heartwood, medieval stave churches, maintenance, architectural conservation, preservation, tarring experiments, weathering, characterisation, gas chromatography-mass spectrometry, GC-MS, abietic acid, dehydroabietic acid, resin acids

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