Deterioration of CLT under Humid and Dry Cyclic Climate

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1 Introduction

Cross laminated timber (CLT) are composed of longitudinal layers and cross layers. And the laminations of the adjoin layers are glued orthogonally. The layer arrangement of CLT cause uneven swelling and shrinkage between the adjoin layers particularly under humid and dry cyclic climate. Oshima, A. (2017) indicated that this uneven swelling and shrinkage between the adjoin layers occasionally cause distortion or deformation of the laminations such as check and shake, warp and delamination. Lepage, R.T.M. (2012) measured the response of CLT under changing moisture conditions and also simulated the its response. As there is limited knowledge for the distortion of CLT composed of Japanese species a series of tests were carried out to estimate the mechanism of distortion of the CLT and to evaluate the capability of surface coating or surface painting against the distortion prevention.

2 Shrinkage and Swelling of CLT and Glue-Laminated Timber (GLT)

CLT are supposed to shrink as illustrated in figure 1(a) under drying process. This deformation is caused by the composition of CLT and the shrinkage ratio of wood. As for glue-laminated timbers (GLT) the direction of the laminations is same for all layers. For this lamination arrangement all the layers will deform in a similar way as illustrated in figure 1(b).

![Deformation of CLT and GLT under humid to dry climate (Cross section).](image)

To verify the assumption that CLT and GLT deform differently when they shrink or swell the deformation of the cross section of CLT and GLT under humid and dry cyclic climate was measure. The deformation of CLT was approximately two times larger than that of the GLT. CLT seem to have larger shrinkage and swelling than GLT. As to the damages of the cross
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section of CLT and GLT where GLT had only one standing out crack CLT had few cracks on its lamination and gaps between the adjoining laminations.

3 Effect of Weather Resistant Paint Against Distortion Reduction

To evaluate how the weather resistant paint can reduce the distortion of CLT under humid and dry cyclic climate test specimens painted by three different types of weather resistance paint were put in chamber with humid and dry cyclic climate. The movement of the CLT with no painting was the largest and the movement of CLT painted with film forming type paint was the smallest. The movement of CLT painted with penetrating type paint was almost same to that of CLT with no painting. The film forming type paint seems to work well as to reduce the deformation of CLT under humid and dry climate. And the penetrating type paint seem to not work well as to reduce the deformation of CLT.

4 Effect of the Surface Direction (Sap-Side or Heart-Side)

To verify the effect of the surface direction of the out most layer on the distortion of the laminations CLT composed of sap-side surface and CLT composed of heart-side surface were tested for their distortion. In general, CLT composed of laminations with heart wood side on the surface side had relatively larger deformation than CLT composed of laminations with sap wood side on the surface side. This test results indicate that one solution to reduce the moisture related deformation of CLT is to arrange the out most laminations of CLT so as to cover the surface of CLT with the sap wood side of the laminations.

5 Conclusion

A series of tests were carried out to estimate the mechanism of distortion of the CLT and to evaluate the capability of surface coating or surface painting against the distortion prevention. The results are summarized as follows;
- The deformation of CLT was approximately two times larger than that of the GLT. CLT showed larger shrinkage and swelling than GLT. The arrangement of the lamination is supposed to cause this difference.
- The film forming type paint seems to work well as to reduce the deformation of CLT under humid and dry climate. And the penetrating type paint seem to not work well as for reducing the deformation of CLT.
- One solution to reduce the moisture related deformation of CLT is to arrange the out most laminations of CLT so as to cover the surface of CLT with the sap wood side of the laminations.

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