

TALLINNA LAULULAVA RISTKIHTNAELPUIDUST
KATUSE KATTEPLAADI KATSETAMINE
STAATILISEL KOORMAMISEL

STATIC LOAD TESTING OF THE MECHANICALLY JOINTED CROSS
LAMINATED TIMBER ROOF PLATE OF TALLINN SONG FESTIVALŠ
TRIBUNE

EA 60 LT (inseneriõpe)

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KOKKUVÕTE

Tallinna Lauluväljak on eestlastele väga oluline rahvuslik objekt. Samuti on see Eestit külastavatele turistidele üks tõenäolisemaid sihtpunkte, mida Tallinnas külastada. Hetkel on laululava kõlaekraan vana ja lagunenu ning vajab renoveerimist. Käesolev magistritöö on kirjutatud eesmärgiga aidata kaasa kõlaekraani taastamisele, viies läbi katseid ning analüüsid saadud tulemusi.

Uueks puitkatte materjaliks planeeritakse kasutada kolmekihilist ristkihtnaelpuit-koorikut. Esimese kihi moodustavad profiillauad mõõtmetega 38x120 mm, teiseks kihiks on sellega risti olevad 32x100 mm ehituslauad ning kolmandaks kihiks on diagonaalselt paiknevad 32x100 mm ehituslauad. Ristkihtnaelpuitpaneeli katsetamiseks lumekoormusele konstrueeriti võimalikult sarnane struktuur, mis kajastab hetkel eksisteerivat trosside kandesüsteemi. Leiti, et käesoleva töö katsetulemuste põhjal on ristkihtnaelpuitkoorik sobiv materjal laulukaares katusele, kuna töötab lumekoormuse rakendumisel elastses staadiumis.

Oluliseks aspektiks kujunes katsekeha katsetamise käigus puidukihtide ühendamise viis – tavaliste ehitusnaelte asemel tuleks kasutada kammnaelu, mis väldiks naelte puidu seest välja tulemist koormuste rakendumisel.

Edasise uurimise käigus määrati standardi EVS-EN 408:2010+A1 järgi katsekehade paindeelastsusmoodulid. Selgus, et konstruktsioon, mille keskmiseks kihiks on ristikiht, on ligikaudu kaks korda jäigem, kui konstruktsioon, mille keskmise kihi moodustab pikikiht. Katsekehas, suunas, kus keskmine kiht on risti, on elastsusmoodul ligikaudu 900 N/mm² ja suunas, kus keskmine kiht on pikkupidi, on elastsusmoodul ligikaudu 470 N/mm². Mõlemal juhul ei olnud määrav, kummalt poolt katsekeha koormati.

Võrdlusmomendi loomiseks viidi läbi ka teoreetilised arvutused kahel erineval meetodil leidmaks lokaalsed elastsusmoodulid. Nii gamma, kui ka vedru meetodil leitud elastsusmoodulid ei erinenud teineteisest olulisel määral, 4-11%, kuid osad arvutuste ning reaalsed katsetulemused erinesid kuni 47%. Mõnel juhul, nagu näiteks katsekeha 1R puhul, oli erinevus äärmiselt minimaalne, jäädes alla 5%. Selle töö puhul, ligikaudse elastsusmooduli määramiseks, antud arvutusmeetodid osutusid sobivateks.

Töö autori arvates sobib katsetatud konstruktsiooni tüüp asendada praegust, vahetamist vajavat, kõlaekraani puitosa. Antud mudeli kasuks räägib ka asjaolu, et selle kasutamine

ehitamisel toimub objektil ning ei ole sõltuv erinevatest trossiavade suurustest ega vaja ajamahukat üksikmoodulite mõõdistamist ja valmistamist. Sobivaima lahenduse leidmiseks laululava kõlaekraani renoveerimisel tuleks kaaluda ka erinevate taastamismeetodite majanduslikke aspekte – praegu puudub hinnang ristkihtnaelpuitkooriku võimaliku kulukuse kohta võrreldes teiste võimalike variantidega.

SUMMARY

The stage at the Tallinn Singing Festival grounds has always been of a significant importance for Estonians and their national identity. Since the grounds are being visited daily by tourists, are playing host to many concerts and events, its state of well-being is of utmost importance. The arc of the stage is in dismal condition – the wooden panels have disintegrated over time due to the weather conditions.

In this thesis, the testing of the wooden part deemed to be used for the planned reconstruction of the arc took place. The wooden part consists of a triple layer wood shell, in which the bottom part consists of a 38-mm longitudinal layer, middle part is made of a 32-mm cross layer and top part consists of a 32-mm diagonal layer. The layers are connected by 2.5 x 60 mm nails and at each crossing of planks, two nails were inserted. A 5 x 5 m testing unit was constructed and weighted down by distributed static loads imitating the application of weight by snow. It was found that at the given snow load rate, the construction works in the elastic mode.

In further testing, the 5 x 5 m model was cut into 1 x 2.1 m strips and local, as well as global, modulus of elasticity was found following the standard EVS-EN 408:2010+A1:2012. As a result, it was discovered that for the testing unit at the direction in which the middle layer is perpendicular, the modulus of elasticity is about 900 N/mm² and at the direction in which the middle layer is lengthwise, the modulus of elasticity is 470 N/mm². In both cases it was irrelevant on which side the weights were applied.

To establish a moment of comparison, theoretical calculations for which two different methods were used to assess the local moduli of elasticities – the modified gamma-process [10] and the spring model method [11]. The results did not vary much, on average 9%, however, few computational and measured results differed up to 47%. In some cases, such as testing unit 1R, the difference in results were minimal, staying well below 5%. The suitability of the calculation methods used for this thesis in order to assess the approximate modulus of elasticity were deemed satisfactory.

The author of this thesis finds that the tested construction type is fitting to replace the current, in dire need of repair, wooden part of the Singing Festival grounds stage arc. It is also important to note that one of the advantages for the use of such model to construct is the fact the building process takes place at the site itself and does not require time-consuming sizing and compilation of single units. It is necessary to weigh the pros and cons of the economic aspects of different renovation methods in order to find the most appropriate cost-effective solution.

As of now, the assessment of the possible costs involved using the cross laminated nail timber shell in comparison to other possible timber construction options is not available.