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PAEKIVI KILLUSTIKU ASENDAMINE PAISUTATUD KERGKLAASKILLUSTIKUGA BETOONISEGUS

REPLACEMENT OF LIMESTONE AGGREGATES WITH EXPANDED LIGHTWEIGHT GLASS AGGREGATES IN CONCRETE MIXES

MAGISTRITÖÖ

Üliõpilane: .....
/nimi/

Üliõpilaskood .....

Juhendaja: .....
/nimi, amet/

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KOKKUVÕTE

Käesoleva magistritöö eesmärgiks oli uurida paekivi killustiku asendamist paisutatud kergklaaskillustikuga betoonisegus. Esimeses osas esitati uurimisöö teoreetiline taust, kus kirjeldati betooni koostisosi ja nende omadusi koos näidetega erialasest kirjandusest. Magistritöö teises pooles esitati katsete kirjeldus ning analüüsiti katsetulemusi.

Paisutatud kergklaaskillustiku mõju uurimiseks valmistati kokku 30 katseseeriat ning summaarselt 334 L segu. Seejuures varieeriti paisutatud kergklaas- ja paekivikillustiku osakaalusid ning lisatud vee kogust, katsetati vibreerimise mõju materjali jaotusele betoonis ning uuriti kergtäitematerjaliga betooni soojuserijuhtivust. Kasutatud täitematerjalidel määrati terastikulised koostised ning lisaks katsetati kolme erineva fraktsiooni kergklaasi ja uuriti selle mõju segregeerumisele.

Katseseeriate peamiseks probleemiks osutus täitematerjalide suures vahemikus kõikuv tihedus, mis määras suuresti betoonisegu valmistamise katsemeetodi ning valmistatud segu konsistentsi. Paisutatud kergklaas on suletud pooridega materjal, kuid fraktsiooniks purustamisel lõhutakse pinnapealsed poorid, mis segusse lisatavat vett endas hoiavad. Lisaks suletud pooride struktuurile, muudab materjali väike tihedus keeruliseks selle paiknemise kontrollimise betoonis.

Paisutatud kergklaas on peamiselt klaasijäätmete taaskasutuse produkt ning ammenduvate looduslike täitematerjalide valguses on vajalik nii kergklaasi kui ka muude alternatiivsete rohelise jalajäljega täitematerjalide mõju betoonis uurida.
Katsete planeerimisel seati eesmärk, et uuritavat betooni saaks kasutada väliskeskkonna tingimuste eest kaitstuna (nt katusekalded), mistõttu pole käesolevas uurimistöös katsetatud selle mõju külmakindlusele.
Käesoleva magistritöö katselises osas toodi välja materjali puudujäägid ning pakuti lahendused nende piiramiseks. Järeldati, et kergklaasi kasutamine betoonis muudab konstruktsiooni tiheduse ja massi väiksemaks, mis vähendab kandvale konstruktsioonile mõjuvat koormust. Samuti leiti, et kergklaasi osakaalu suurenedes muutub betooni soojuserijuhtivus märgatavalt paremuse poole, millega on võimalik tagada betoonile paremad soojuslikud omadused. Kergklaasi sisaldus mõjutab betoonisegu konsistentsi ning veevajadust. Mida suurem on segu konsistents, seda suurem on täitematerjalide segregeerumine.
Katsetulemustest selgus, et kergklaasist täitega betooni tugevus langeb osakaalu suurenemisel üsna kiirelt, mistõttu seab autor küsimärgi alla selle kasutamise kandvates

tarindites, pidades silmas ka segregeerumise ohtu. Sellegi poolest on kergklaasil betoonis kasutamiseks potentsiaali ning edasine uurimine on vajalik, et muuta selle kasutamine laialdasemaks.

SUMMARY

The aim of this master's thesis was to study replacement of limestone aggregates with expanded lightweight glass aggregates in concrete mixtures. In the first part, the theoretical background of the research was presented, where the ingredients of concrete and their properties were described together with examples from scientific literature. In the second part of the master's thesis, a description of the experimental plan was presented along with results and discussion.

A total of 30 test series and a total of 334 L of mixture were prepared to investigate the effect of expanded lightweight glass aggregate in concrete. The proportions of expanded lightweight aggregate, natural aggregate and the amount of added water were varied, the effect of time under compaction on the distribution of the aggregates in concrete was tested, and thermal conductivity of concrete was investigated. A grading analysis of quartz sand, limestone aggregate and expanded lightweight glass aggregate of three different fractions was conducted to test its effect on segregation.

The main issue of the test series turned out to be the fluctuating density of the aggregates, which largely determined the production method of concrete mixtures and the workability of the prepared mixtures. Expanded lightweight glass is a material with evenly distributed closed inner pores, but when broken into fractions, it creates open pores on the surface that collects and withholds added water from reacting with cement. In addition to the closed pore structure, the low density of the material makes it difficult to control its placement in concrete.

Expanded lightweight glass is mainly a product of glass waste recycling, and in the light of depleting natural aggregates, it is necessary to study the effect of both lightweight glass and other alternative aggregates with a green footprint in concrete. In the design stage, the goal was set that the investigated concrete could be used protected from external environment conditions (e.g. roof slopes), so this research has not tested its effect on frost resistance.
In the experimental part of this master's thesis, the deficiencies of the material were presented and the solutions to limit them were proposed. It was concluded that the use of lightweight aggregate in concrete reduces the density and mass of the structure, thereby reducing the load on the load-bearing structure. It was also found that as the proportion of lightweight aggregate increases, the thermal conductivity of concrete improves significantly, allowing for better thermal properties of concrete. The content of lightweight aggregate affects consistency and water requirement of the concrete mix.

The higher the consistency of the mix, the greater the segregation of the aggregates used.

The test results revealed, that the strength of concrete with lightweight aggregate decreases quite rapidly as the replaced proportion increases, raising questions about its use in load-bearing structures, considering the risk of segregation. Nevertheless, lightweight glass has the potential for use in concrete, and further research is necessary to make its use more widespread.