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# HOONE ERINEVATE VUNDEERIMISLAHENDUSTE ANALÜÜS

ANALYSIS OF DIFFERENT FOUNDATION SOLUTIONS FOR A BUILDING

MAGISTRITÖÖ

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## KOKKUVÕTE

Käesoleva magistritöö peamiseks eesmärgiks oli mitmekorruselise korterelamu-ärihoonele plaat- ja lintvundamentide dimensioneerimine ja vajumite arvutus ning plaadi konstrueerimine.

Töö aluseks võeti vastav arhitektuurne eelprojekt ning geoloogiliste uuringute aruanne, mille põhjal on antud uurimispiirkonnas ehitusgeoloogilised tingimused keerulised, kuid madalvundamendi rajamine siiski mõeldav.

Töös määrati esmalt hoonele koormused vastavalt standardi EVS-EN 1990:2002 nõuetele. Seejärel teostati geotehnilised arvutused. Plaatvundamendi aluse kandevõime kontrolli järel arvutati sellele summeerimismeetodit kasutades vajum, mis osutus veidi suuremaks üldiselt raudbetoonehitistele lubatud vajumi piirväärtusest. Pärast plaatvundamendi vajumi leidmist dimensioneeriti lintvundamentide laiused selliselt, et neil tekkivad vajumid oleksid võimalikult lähedased plaadi vajumile. Rahuldava tulemuseni jõudes alles kontrolliti lintvundamentide aluse kandevõimet.

Plaatvundamendi sisejõudude leidmiseks koostati arvutusprogrammis Autodesk Robot Structural Analysis järk-järgult vastav mudel, mille kokku panemise protsess võttis palju aega, kuna projekteerimise algusetapis tuli tihti ette muudatusi nii vundamendi kuju kui ka mõõtmete osas ning iga kord tuli kas mudelisse täiendusi või täiesti uus mudel teha. See aga andis töö autorile hulgaliselt vajalike oskusi ning vilumust antud programmiga töötamiseks. Sisejõud leiti nii kasutuspiirseisundis kui ka kandepiirseisundis. Plaadi armeerimiseks kasutati peamiselt just kasutuspiirseisundi jaoks mõeldud kombinatsiooni ja sisejõude, et läbi viia plaadis tekkivate pragude laiuse arvutused, millest tulenevad armeerimisvajadused olid tihti määravamad kui tugevusarvutuste omad.

Lisaks tehti läbi vaivundamendi projekteerimise aluseks olevad vaia kandevõime ja rostvargi arvutused, et koostada rostvargi plaan, millega tekitada võrdlusmoment plaat- ja vaivundamendi vahel. Kinnitust leidis tõsiasi, et kahe nimetatud vundamentitüübi suurimaks erinevuseks on betooni maht, mis suurenes 52 %. Suurema materjalikulu kõrval nõuab vaiade puurimine ka lisatööd ja -aega ning seetõttu suureneb ehituse maksumus. See on ühtlasi ka põhjuseks, miks püütakse vaivundamendi rajamist võimalusel vältida, olenemata tema eelistest, milleks on väga väikesed vajumid ja projekteerimise lihtsus võrreldes plaatvundamendiga, kus vajumite ja sisejõudude leidmisel on pinnaseomaduste mõningase määramatuse tõttu kasutatavaid lihtsustavaid meetodeid väga palju ning neist sobiva valimine ning saadud tulemuste usaldusväärsuse hindamine keeruline.

Magistritöös püstitatud eesmärk sai täidetud ning erialaseid teadmisi sai rakendatud reaalses tingimustes, mille tulemusena on autoril hea kogemus ja ettevalmistus vundamentide projekteerimiseks ka tulevikus.

# SUMMARY

## ANALYSIS OF DIFFERENT FOUNDATION SOLUTIONS FOR A BUILDING

In the course of this master's thesis raft and strip foundations for a multi-storey apartment and business building were designed with the calculation of settlements and construction of the plate.

The work was based on an architectural preliminary design and geological research report, which stated that the soil conditions of the research area were complex, but the creation of a shallow foundation would be conceivable.

At first, the loads of the building were determined in accordance with the standard EVS-EN 1990:2002. Then the geotechnical calculations were performed. After the inspection of the load bearing capacity of the soil under the raft, the settlement was calculated using the summation method. The settlement turned out to be slightly bigger than for the reinforced concrete buildings in general. The widths of the strip foundations were then dimensioned in a way that their settlements would be as close as possible to the one of the raft. Only after reaching a satisfactory result the bearing capacities of the soil under the strip foundations were calculated.

A model was constructed step by step in a program Autodesk Robot Structural Analysis to find the internal forces of the raft. The process of constructing the model was very time consuming due to many changes in the design and dimensions of the raft in the early stages and that caused the need for additions or a completely new model every now and then. This, however, gave the author many necessary new skills and experience to work with the program. The internal forces were found both in the serviceability limit state and the ultimate limit state. The results of the serviceability limit state were mostly used because the calculations of the width of the cracks were often more decisive than the strength calculations in the ultimate limit state.

Additional calculations were made to design a pile foundation for the building in order to be able to compare the two foundation types. It was confirmed by fact that the biggest difference between the two types is in the volume of concrete used in construction of the foundations. The volume of concrete used in pile foundation was found to be 52 % bigger than in the raft. This makes it more expensive and more time consuming as it also requires drilling of the piles and therefore greatly increases the cost of construction. This is also the reason why the construction of pile foundations is often avoided if possible, regardless of its benefits, which are a very small settlement and the simplicity of the designing process compared to those of the raft foundation where settlement and internal forces are much harder to find due to uncertainty in the properties of the soil. That is why there are so many different simplifying methods and it is difficult to choose the best fitting one for the particular conditions and to evaluate the reliability of the results.

The goal stated in this master's thesis was met and the level of knowledge of the author was greatly increased with applying it to real-world conditions. As a result, the author gained experience in the design of foundations and is prepared better for the future.