KOKKUVÕTE

Antud lõputöö eesmärk oli projekteerida Formula Student võistlussarjas osalevale FEST24 vormelile esimene ja tagumine stabilisaatorvarras.

Esmalt alustati eelmise aasta vormeli analüüsi ülesehituse muutmisega ning seejärel kontrolliti üle materjali valik ning laagrite dimensioneerimine. Täpsemaks reguleerimiseks valmistati süsteem, mille abil saab muuta stabilisaatori jäikust abivahenditeta. Vormelil otsustati kasutada alumiiniumist monoliitset lehtvedrudega reguleeritavat U-tüüpi stabilisaatorvarrast, sest süsiniktoru nihkemooduli väärtus oli projekteerimise hetkel teadmata ning keevitatavate alumiinium torude voolepiir on liiga väike.

Teises peatükis käsitleti stabilisaatorvarda komponentide projekteerimist ning valikut. Vastavalt valitud laagritele projekteeriti kinnituskõrv, mille esimese ja viimase versiooni massi vahe oli pool grammi, kuid läbipainet vähendati peaaegu kahekordselt. Lehtvedrul saavutati pingete ühtlane jaotumine ning soovitud varuteguri juures maksimaalne läbipaine. Stabilisaatorvarraste võlli diameetrid arvutati ühtlase ümarvarda väändenurga valemi abil. Ühendusvarras valmistati massi säästmise eesmärgil süsinikkiud torust, mille otstes on kuulliigendid. Reguleerimise lihtsustamiseks tehti lehtvedruga ühenduv seib, mille asend fikseeritakse tihvti ja splindiga.

Kolmandas peatükis keskenduti projekteeritud detailide vastavust analüüsitule. Selleks teostati mitmeid erinevaid katseid ning tulemusteks oli, et enamus detailid on jäigemad ja tugevamad kui projekteeritud. Esmalt valideeriti esimese ja tagumise stabilisaatorvarda jäikused, kust selgus, et jäiga ja pooljäiga asendi erinevus projekteerituga oli 4%, kuid pehme asend erines 15%. Pehme asendi viga tulenes lehtvedru jäikusest, mida kinnitas ka lehtvedru katse, kus lehtvedrud purunesid oodatust suurema jõu juures. Ühendusvarda katsest sai järeldada, et ühendusvarda varutegurid on arvutatust suuremad, sest purunes kuulliigendi keere. Massi vähendamise eesmärgil kaaluti süsiniktorust võlli valmistamist, kuid esmalt tuli kindlaks teha süsiniktoru nihkemoodul. Selleks tehti katsekeha, kus torusse ei puuritud ühtegi ava, et vältida pingekonsetraatoreid, vaid tehti konnektori sisse kanalid, mis suunavad liimi liimpinnale. Katse lõppes alumiiniumi purunemisega väändele, kuid graafikust sai siiski arvutada toru nihkemooduli.

SUMMARY

The aim of this thesis was to design the front and rear anti-roll bars for the FEST24 formula car participating in the Formula Student competition series.

First part started by changing the structure of the analysis of last year's formula car, followed by checking the choice of materials and the dimensioning of the bearings. For finer adjustment, a system was designed to change the stiffness of the anti-roll bar without tools. It was decided to use a blade adjustable monolithic U-shape anti-roll bar made of alumiinium, as the value of the shear modulus of the carbon tube was unknown at the time of design and the yield strength of welded aluminum tubes is too low.

The second chapter adddressed the design and selection of anti-roll bar components. According to the selected bearings, a mounting bracket was designed, where the mass difference between the first and last versions was half a gram, but the deflection was almost halved. Uniform stress distribution and maximum deflection at the desired safety factor were achieved on the blade. The shaft diameters of the stabilizer bars were calculated using the round bar torsion equation. To save weight, the connecting rod was made from a carbon fiber tube with ball joints at the ends. For ease of adjustment, a washer connected to the blade was made, whose position is fixed with a pin and spring cotter pin.

The third chapter focused on the compliance of the designed details with the analysis results. For this purpose, several different tests were carried out and the results showed that most of the details are stiffer and stronger than designed. Firstly, the stiffnesses of the front and rear anti-roll bars were validated, revealing that the difference between the stiff and semi-stiff position compared to the design was 4% while the soft position differed by 15%. The error in soft position arose from the stiffness of the blade, as confirmed by the blade test, where the blades broke at a higher force than expected. The test of the linkarm concluded that the safety factors of the linkarms are higher than calculated, because the thread of the rod end broke. For the purpose of reducing mass, the possibility of making the shaft from a carbon tube was considered, but first, the modulus of rigidity of the carbon tube had to be determined. For this, a test specimen was made with no holes drilled into the tube to avoid stress concentrators; instead, channels were made inside the connector to direct the adhesive to the adhesive surface. The test ended with the aluminum breaking on torsion, but the shear modulus of the tube could still be calculated from the graph.