**Table of contents**

**Acknowledgements** i

**Abstract** iii

**1. INTRODUCTION** 1

**1.1. Objectives** 1

**1.2. Electricity Pylons** 2

**1.3. Structure** 3

**2. DESIGN OF LATTICE TOWERS** 5

**2.1. General Principles** 5

**2.2. Design Loads** 6

**2.3. Resistance Verification** 7

**2.4. Stability Verification** 7

2.4.1. Effective Slenderness Factor - K 7

2.4.2. Buckling Lenght 10

**2.5. Connection Design** 14

**3. GENETIC ALGORITHM** 15

**3.1. Overview** 15

**3.2. Fundamental Elements of a Genetic Algorithm** 16

3.2.1. Individual 16

3.2.2. Initial Population 17

3.2.3. Fitness Function 18

3.2.4. Selection Function 18

3.2.4.1. Roulette wheel 19

3.2.4.1. Tournament selection 19

3.2.5. Genetic Operators 20

3.2.5.1. Crossover 20

3.2.5.2. Mutation 21

3.2.5. Genetic Operators 20

3.2.4. Termination Criteria 21

**4. PROGRAM DESCRIPTION** 23

**4.1. Summary** 23

**4.2. Program Flow** 23

**4.3. Base Genetic Code** 25

**4.4. Initial Population** 28

**4.5. Evaluate Function** 29

**4.6. Repair Function** 32

**4.7. Selection Function** 33

**4.8. Genetic Operators** 34

4.8.1. Crossover 34

4.8.2. Gaussian Mutation 34

**5. CASE STUDY** 37

**5.1. Base Model** 37

**5.2. Program Setup** 39

**5.3. Results** 40

5.3.1. Postprocessing 40

5.3.2. Analysis 42

**5.4. Future Work** 43

**REFERENCES** 45

**List of figures**

Fig.1.1 – Power lines designed to withstand snow, Iceland 2

Fig.1.2 – Test bench – India 3

Fig.2.1 – Steel poles 6

Fig.2.2 – Lattice tower 6

Fig.2.3 – EC3 table G.1 from annex G 8

Fig.2.4 – EC3 table G.2 from annex G 9

Fig.2.5 – EC3 table G.3 from annex G 10

Fig.2.6 – EC3 Figure H.1 from annex H 11

Fig.2.7 – Increased number of horizontal divisions 11

Fig.2.8 – EC3 Figure H.3 from annex H 12

Fig.2.9 – EC3 Figure H.4 from annex H 13

Fig.3.1 – Basic GA operations 15

Fig.3.2 – Chromosome structure and values 16

Fig.3.3 – Basic bit string chromosome 17

Fig.3.4 – More complex chromosome datatype 17

Fig.3.5 – Random vs Seeded population 17

Fig.3.6 – Roulette wheel: A is better than G, therefore selected more often 19

Fig.3.7 – Tournament selection 20

Fig.3.8 – Double and single point crossover 20

Fig.4.1 – User interface 24

Fig.4.2 – Interaction between key modules 25

Fig.4.3 – Grasshopper and Rhino model 26

Fig.4.4 – IAM: Different bracing conditions 30

Fig.4.5 – Tapered normal distribution 35

Fig.5.1 – Base model 37

Fig.5.2 – Arm nodes 38

Fig.5.3 – Plan view 40

Fig.5.4 – Critical quadrant, front and side planes 40

Fig.5.5 – Legs with secondary bracing added 41

**Table list**

Table 4.1 – DNA definition 27

Table 4.2 – Initial mutation implementation 28

Table 4.3 – Evaluate function call 29

Table 4.4 – IAM scan (leg scan excerpt) 29

Table 4.5 – EC3 verification for leg members 31

Table 4.6 –Repair function excerpt 33

Table 4.7 – Tournament selection 34

Table 4.8 – Crossover function applied to the bar array 34

Table 4.9 – Gaussian mutation algorithm 35

Table 4.10 – Clamp function 36

Table 4.11 – Mutation function 36

Table 5.1 – Base model weight distribution 38

Table 5.2 – Load cases 39

Table 5.3 – Final structure weight distribution 42