ANALYZE OF RELIABILITY OF GEARS

Assoc. prof. Nicolae UNGUREANU, PhD.[1],Dipl-eng. Miorita UNGUREANU[2],
Lecturer Sorin MIHAILESCU, PhD.[3]

[1]North University of Baia Mare, Dr. V. Babes Street 62A, RO-4800, Baia Mare
[2]Ore Mining Baia Sprie, Montana Street 20, RO-4847, Baia Sprie
[3]University of Petrosani, Universitatii Street 20, RO-2675, Petrosani
Phone +40-(0)62-276259 int. 17, Fax +40-(0)62-276153 E-mail:unicu@ubm.ro

ABSTRACT: The papers presents the results of the analyze of reliability of gears. The graphic representation of the equations for limit wear load and reliability of gears, built with Mathcad, permit to studies the influences of each factor from equations to wear and reliability.

The papers presents also some methods for improve the reliability of gears.

KEY WORDS: *limit wear load, allowable wear, reliability*

1. Introduction

The gears are base components of mechanical transmissions, machine parts of all machines and equipments, industrials or non-industrials.

The performances of machines, the reliability and the useful life of machines depend in many cases by performances and reliability of gears. The performances of gears actuate too the fabrication price, the maintenance price, the prices of materials, in one word the efficiency of the machines.[2][3][6]

These are the reasons for studies the damage causes, the finding the influences of different factors to wear of gears and to reliability of gears.

The failures of gears have many aspects and each aspect have particular causes.[4][5] The diagram of damages causes of gears are presented in figure 1

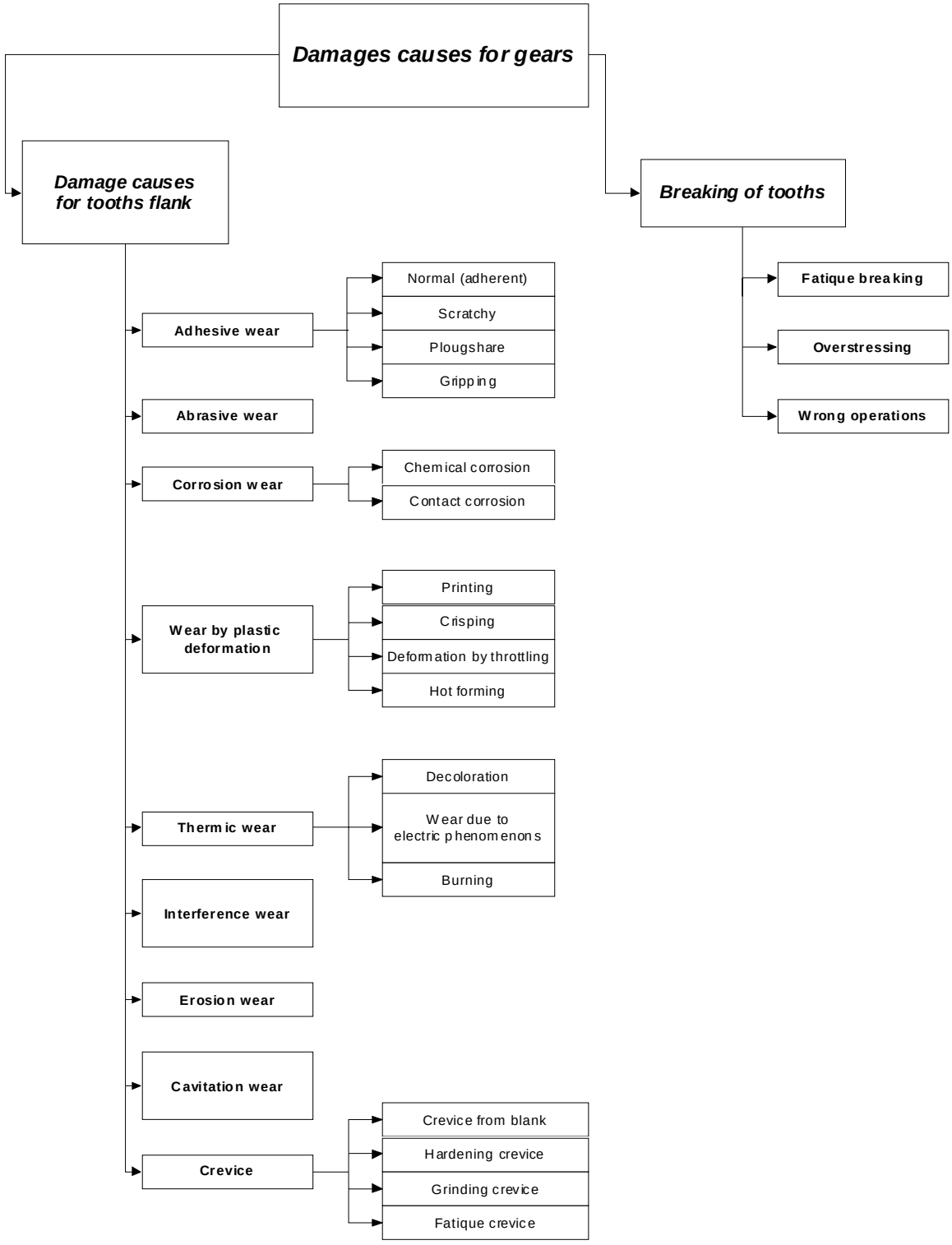


Fig. 1 The damage causes of gears

2. Analyze of limit wear load and reliability of gears

For calculus of limit wear load L we use the relation [1]:

$$L = \left(\frac{K}{W_w} \right)^X \tag{1}$$

where:

$$K = \frac{K_1 \cdot \sin \varphi}{4} \tag{2}$$

The notation of relations represents:

- K_1 - analytic factor load-stress, function by materials couple;
- X – experimental coefficient;
- φ- pressure angle;
- W_W – allowable wear load.

The allowable wear load can be determined with relation:

$$W_W = B \cdot K \cdot D_d \cdot \frac{1250 \cdot Z_p}{Z_c + Z_p} \tag{3}$$

In relation (3) the notation represents :

- B – width of tooth ;
- D_d – diameter of division;
- K – analytic factor load-stress of gearing;
- Z_c – number of tooth for driven gear;
- Z_p – number of tooth for drive gear.

If the width of tooth, the diameter of division and analytic factor load-stress of gearing have direct influence to the allowable wear load is interesting to analyze the influence of number of tooth for driven gear and the number of tooth for drive gear. Using the Mathcad 2000 Professional program was designed the graphic variation of W_W function of Z_c and Z_p.

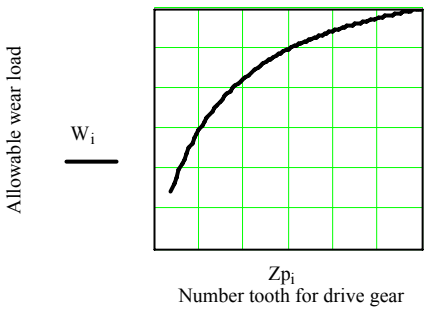


Fig. 2 Influence of number of drive gear to allowable wear load

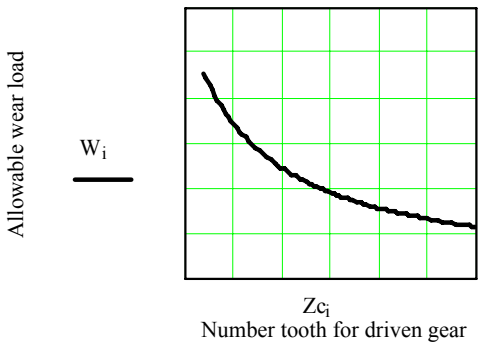
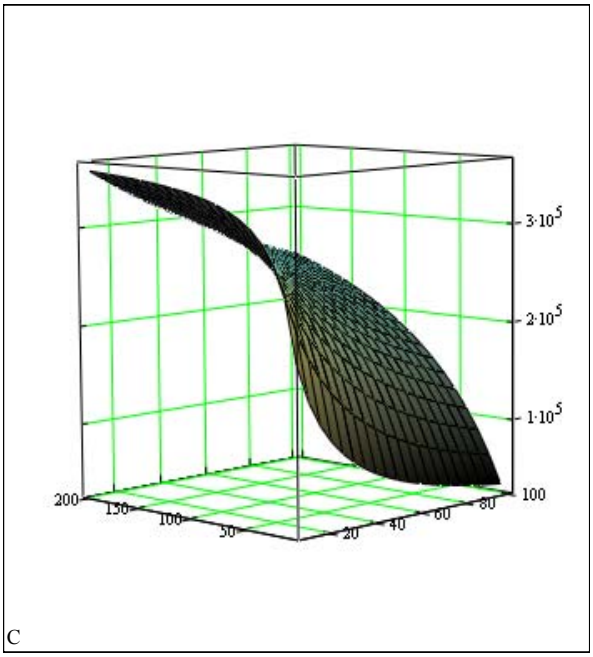


Fig.3 Influence of number of driven gear to allowable wear load



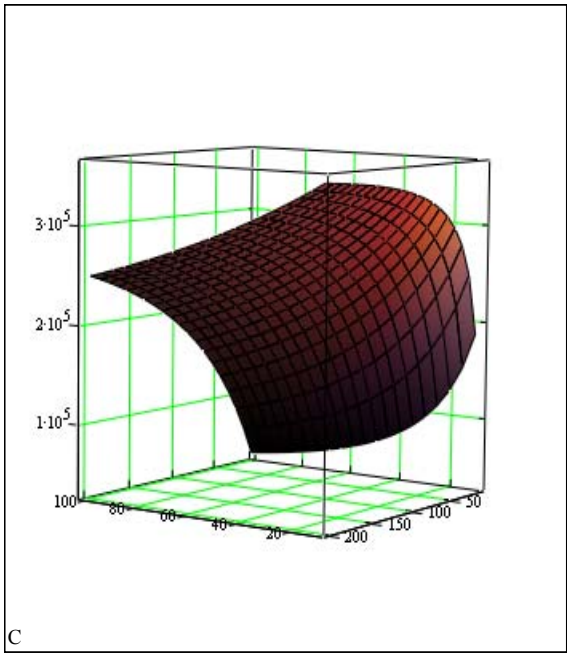


Fig. 4 Influence of number of drive gear and driven gear to allowable wear load

For gears the according reliability law is Weibull law under the form:

$$F(n) = 1 - e^{-\left(\frac{n-\gamma}{\eta}\right)^{\beta}} \tag{4}$$

The variable n is number of contact cycles (x10^6) and the $F(n)$ is the percent of damage. The analyze of relation was make in Mathcad and the results are presented in figures 5-8.

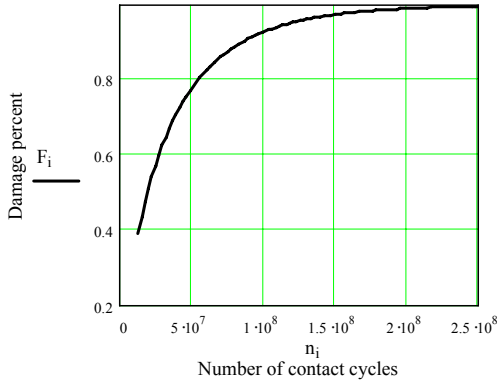


Fig.5 Influence of number of contact cycles to

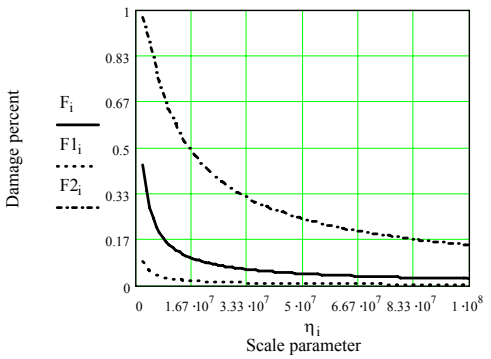


Fig. 6 Influence of scale parameter to

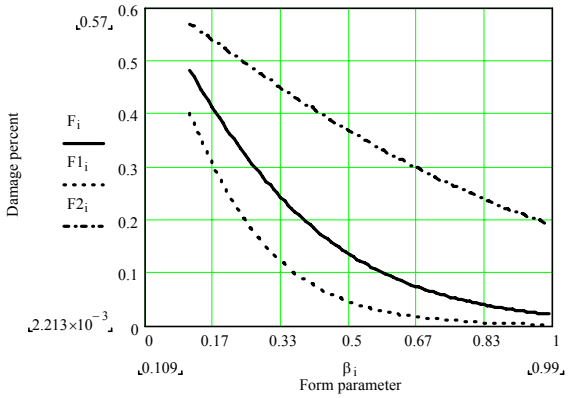


Fig. 7 Influence of form parameter to damage percent

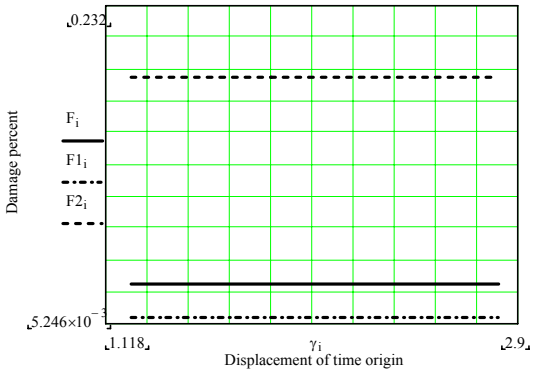


Fig. 8 Influence of displacement of time origin to damage percent

3. Conclusions

The analyze of graphic variation of W_W prove the increase the allowable wear load with the increase the tooth of drive gear and the decrease of the allowable wear load in relation with decrease of number of tooth for driven gear.

The analyze of graphic variation of damage percent (using the Weibull law) show:

- for a big number of contact cycles (more than $2{,}5x10^8$) the probability of damage is 1;
- in the same time a big number of contact cycles ($F2_i$ curves) influences in bad the damage percent indifferent by the form parameter, scale parameter and displacement of time origin;
- the best situations for damage percent is when form parameter and scale parameter have maximum values:
- the displacement of time origin not have influence to damage percent.

4. Bibliography

1. **Antonescu, V., Stichițoiu, D.,** Elemente de teorie şi culegere de probleme de fiabilitate, mentenabilitate, disponibilitate, vol. I, II, Institutul central pentru industria electrotehnică, Oficiul de informare documentară, Bucureşti, 1988

2. **Cătuneanu, V.,** Bazele teoretice ale fiabilității, Editura Academiei R.S.R., Bucureşti, 1983
3. **Florea Al., Vasiu Gh.,** Fiabilitatea utilajului minier, Litografia Institutului de mine Petroşani, 1979
4. **Tudor A.,** Contactul real al suprafețelor de frecare, Editura Academiei Române, Bucureşti 1990.
5. **Tudor A., Prodan Gh., Muntean C., Moțiu R.,** Durabilitatea şi fiabilitatea transmisiilor mecanice, Editura Tehnică, Bucureşti, 1988
6. **Ungureanu N.,** Fiabilitatea, mentenabilitatea şi disponibilitatea elementelor şi sistemelor, Editura Universității de Nord Baia Mare, 2001