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Program for Spur Gears Engagement Factor Determination

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Abstract

The current paper describes how to calculate the engagement factor for spur gears, using a computer program built on the Delphi Integrated Development Environment.

Key words: *program, gear, engagement factor.*

General Considerations

The frontal engagement factor ε_α for unmodified straight-teeth involute profile gear is defined by the ratio between the arc of action and the circular pitch.

The frontal engagement factor value ε_α (which must be higher than 1) is the average number of tooth pairs found in action simultaneously.

This value determines the process of putting teeth into gear, through the cinematic aspect of continuous rotational movement transfer from a gear to the other, and through the dynamic aspect of gear force on the teeth in contact.

Theoretical Summary

The frontal engagement factor for unmodified straight-teeth involute profile gear, can be determined using the following formula:

$$\varepsilon_\alpha = \frac{1}{2\pi}\left[\sqrt{\left(\frac{z_1+2}{\cos\alpha}\right)^2 - z_1^2} + \sqrt{\left(\frac{z_2+2}{\cos\alpha}\right)^2 - z_2^2} - (z_1+z_2)tg\alpha\right], \tag{1}$$

where z_1 and z_2 are the teeth numbers of the active and passive gear.

From the gear ratio formula:

$$u_{12} = |i_{12}| = \frac{z_2}{z_1}, \tag{2}$$

we get:

$$z_2 = u_{12} \cdot z_1 . \tag{2'}$$

For a parallel gear set using helical gears, the over-all engagement factor is:

$$\varepsilon_\gamma = \varepsilon_\alpha + \varepsilon_\beta , \tag{3}$$

where ε_α is the frontal engagement factor, and ε_β is the axial (slope) engagement factor which can be determined using the formula [1]:

$$\varepsilon_\alpha = \frac{1}{2\pi}\left[\sqrt{\left(\frac{z_1 + 2\cos\beta}{\cos\alpha_t}\right)^2 - z_1^2} + \sqrt{\left(\frac{z_2 + 2\cos\beta}{\cos\alpha_t}\right)^2 - z_2^2} - (z_1 + z_2)tg\alpha_t\right], \tag{4}$$

where α_t is the frontal pressure angle and it can be determined using the formula [1]:

$$tg\alpha_t = \frac{tg\alpha_n}{\cos\beta}, \tag{5}$$

where β is the slope angle and α_n is the normal pressure angle.

$$\varepsilon_\beta = \psi_{mn} \cdot \frac{\sin\beta}{\pi}, \tag{6}$$

where ψ_{mn} is the modular coefficient of the teeth width.

Computer Program for Straight and Angled Teeth Spur Gears Engagement Factor Determination

The programming language is Delphi. Delphi Integrated Development Environment allows the development of programs that can execute in the Windows operating system, using Windows-type interfaces, through a Pascal-type programming language. The visual application interfaces can be easily implemented, but the design and development of intelligent and powerful applications cannot be achieved without the programmer’s effort. This involves the design and implementation of efficient problem-related algorithms into the Object Pascal language.

Delphi allows a wide variety of objects, of which the following have been selected:

- the *form* object is a window with certain properties where other objects can be inserted (see fig. 1, fig. 2);
- the *button* object used to access a certain (form) window or to execute a certain command (see fig.3);
- the *edit* object where text can be edited (fig.4);

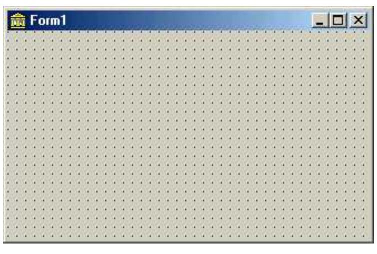

Fig.1. Form window

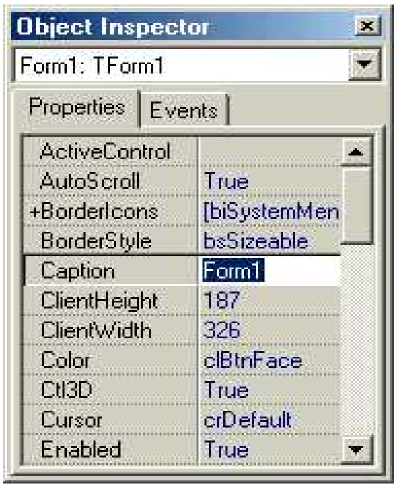

Fig.2. Form object

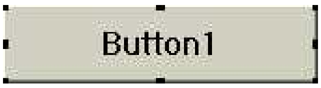

Fig.3. Button object

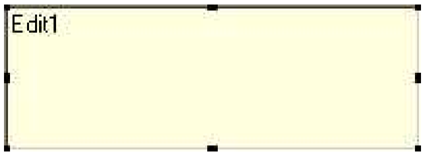

Fig.4. Edit object

- the *group box* and *radio button* object that allows selection of only one of more available options (fig.5).

Fig.5. Group box and radio button object

The current paper describes a computer program for straight and angled teeth spur gears engagement factor determination.

This program's advantage is the considerable reduction of time allocated for the classical calculation of the engagement factor. The program is easy to use, providing an accessible interface for all users, including beginners.

The program has a main menu (fig. 6) where a gear type (straight or angled teeth) can be chosen to determine its engagement factor.

Upon selecting the gear type, a new window will open:

- Straight-teeth spur gear (fig.7);
- Angled-teeth spur gear (fig.10).

The two windows have an "input data" section, where the user must input the gear ratio $u12$, minimum teeth numbers $z1min$ and maximum teeth numbers $z1max$ for the active gear.

Fig. 6. Main Menu

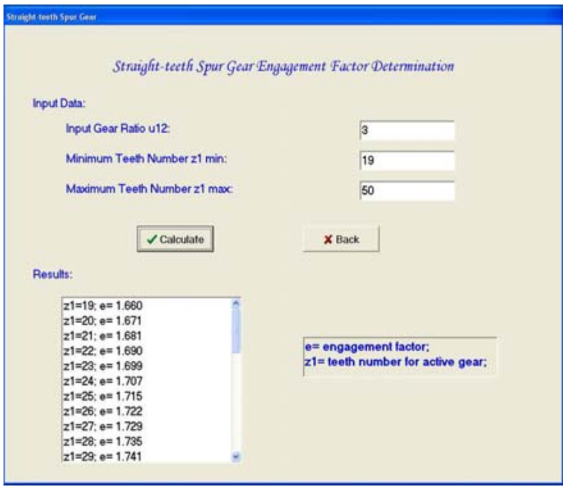

Fig.7. Straight-teeth spur gear.

The program determines the engagement factor for each gear obtained through the increase of the minimum teeth number and the gear ratio, until the maximum teeth number is reached for the active gear. If z1min is lower than 17, an error message will appear (fig. 8). The result will be listed in a “listbox” window.

To close the window, and return to the main menu, the “exit” button will be accessed, and a confirmation message will be displayed (fig. 9).

Fig.8. Error Message.

Fig. 9. Confirmation Message.

In the Angled-Teeth spur gear case (fig. 10), the user can choose between a wide variety of results, because of the division angle variation between 0 and 45 degrees.

Conclusions

The current paper describes how to calculate the frontal engagement factor for involute profiled spur gears with unmodified straight or angled teeth.

The programming environment used is Delphi and the program built offers the advantage of substantially reducing the allocated time for the engagement factor determination using classical methods.

The program is easy to use, offering an accessible interface even to less experienced users.

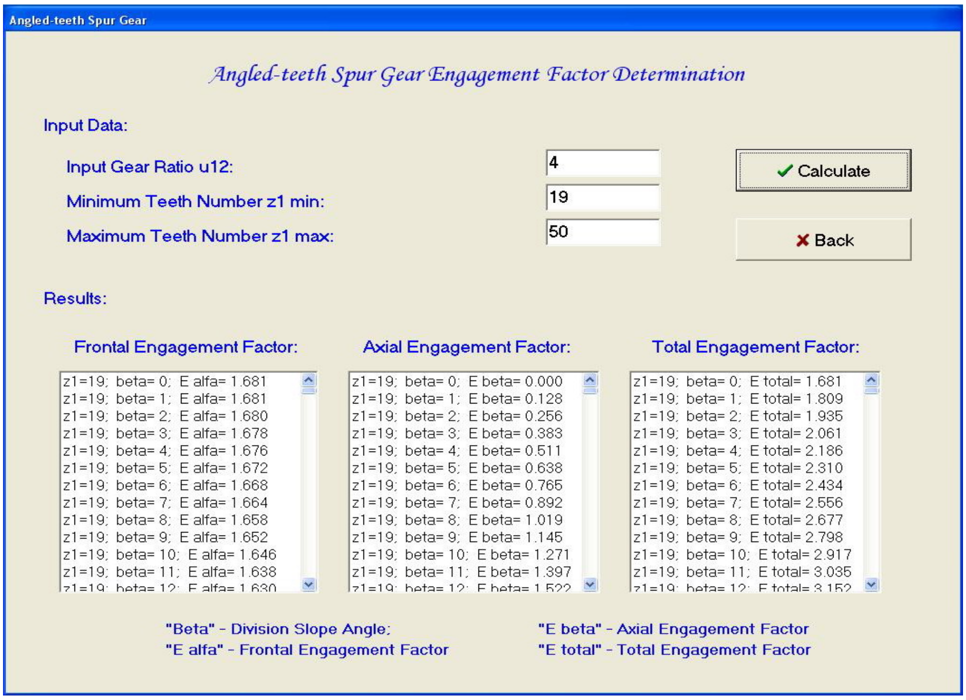

Fig.10. Angled-teeth spur gear.

References

1. M a n e a , G h . , s . a . – *Organe de maşini*, Vol II, Editura Tehnică, Bucureşti, 1959.
2. G r i g o r e N . – *Organe de maşini*. *Transmisii mecanice*, Editura Universităţii din Ploieşti, 2003.
3. G r i g o r e N . – *Organe de maşini*, vol I. *Ansamblări*, Editura Tehnică, Bucureşti, 2000.

Program pentru calculul gradului de acoperire al angrenajelor cilindrice

Rezumat

Lucrarea prezintă un program pentru calculul gradului de acoperire al angrenajelor cilindrice utilizând limbajul de programare Delphi.