PRELIMINARY RESEARCH OF PROTOTYPES HELICAL GEARS FOR POWER TRANSMISSION SYSTEMS

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Abstract

The toothed gears are used in the power transmission systems. It is result from advantages of them (e.g. efficiency, reliability, fatigue life, high-load transmission). In the power transmission systems for trucks, and for cars with back drive, gear pairs are used. In that case it is possible to transfer turning moment under right angle. The most common in use in so-called main axle are bevel or hypoid gear pairs. Differential gears are mainly built basis of straight bevel gears. The paper presents method of preliminary determination of usability bevel gears for transfer turning moment. The method uses gears' models which are made with Rapid Prototyping techniques. The gears are placed in the testbed, which enables to steady load of gear pair. The observation of tooth contact makes possible to preliminary evaluate of correctness of gear pair's working. The tooth contact's changes are observed during gear rotation. The direct observation of tooth gears can be done using transparent material for gears. Besides, it is possible to determine temporary tooth contact and its changes in function of gears' rotation for existing metal gear pairs. In order to analyse, it is necessary to make copy of existing gears vacuum cleaning method. It uses the silicone forms as a template to make copies. It should be use transparent material. The method enables to analyse tooth contact in gear pairs after lifetime, thereby evaluating impact of working on correctness of gear pairs' working.

Keywords: *rapid prototyping, bevel gears*

1. Introduction

In the power transmission systems for contemporary trucks and for some cars (with back drive), there are used gear pairs with bevel or hypoid gears. The utilitarian gears have usually Oerlikon or Gleason system's circular-arc flank line. The final drive changes moment's axle of 90 or near. The efficiency and the reliability of all power transmission system depend on the efficiency and the reliability of final drive. In the all world are conducted the research into increase of efficiency, reliability and silent-running of these gear pairs. The basic index's of correctness of gear pair's working is the tooth contact which is appeared between mating teeth. The contact area, which is standing up on the flanks of teeth during gear pair's working, is very often examined in the industrial conditions. The tooth contact is often marked experimental out. The toothed gears are placed on special control machine. The flanks of one gear are covered by layer of ink and then gears are working under little load [3]. During the gear pair's working, the ink is wiped off as a result of mutual skids. The tooth contact is become on teeth. The tooth contact's observation is not always sufficient. In spite of tooth contact's correctness (the tooth contact appeared on appropriate place on tooth flank), the gear pair can work wrong. It is connected with so called temporary tooth contact, which appears between contacted flanks of teeth. The temporary tooth contact is formed by surfaces of toothed gears working under load and it appears at specific, mutual location of teeth. When the gear rotates in gear pairs, the temporary tooth contact is moved along tooth flanks. The fluidity of gear pairs' working depends on changes of size and location of

the temporary tooth contact. When the temporary tooth contact is changing considerably, the gear pair's working can be probably irregular. In construction of tooting geometry it is aimed at changing of tooth contact in possible little range. Additionally there can be more than one pair of teeth in tooting, so the total tooth contact is the sum of temporary tooth contacts of individual teeth's pairs. In the article is shown the method of determination of temporary tooth contact in loading gear pair. The described method consists in deformation's freezing in gear pair.

2. Test gears

The gears of bevel gears are executed two-stages. At the beginning gears' models are created in CAD environment, and then they are made by Rapid Prototyping technique.

2.1. CAD models

Test gears are prepared in CAD environment. It is used tool-mapping simulation in order to generate gears. It enables to get the gears' geometry, which is consistent with the geometry getting as a result of real machining [4]. Fig. 1 shows the bevel gears, which are created in CAD environment. Discussing gears belong to Gleason SGM systems (Spiral Generated Modify-roll).

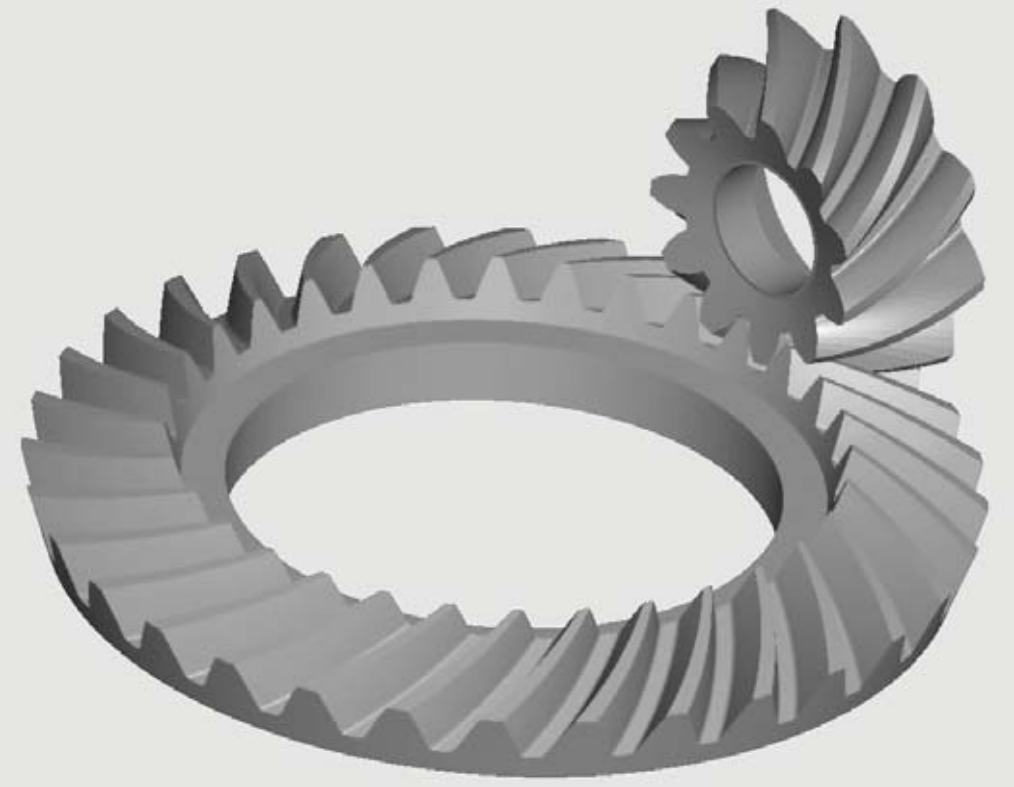

Fig. 1. CAD model of Gleason SGM bevel gears with circular-arc flank line

2.2. Physical gear pair's prototype

The gears have been created in CAD environment and then are made using stereolithography method [1, 2].

3. Observation of tooth contact

The physical gears' models are placed in special testbed (Fig. 3).
The testbed enables to appropriately and mutually place gears in space. This location corresponds

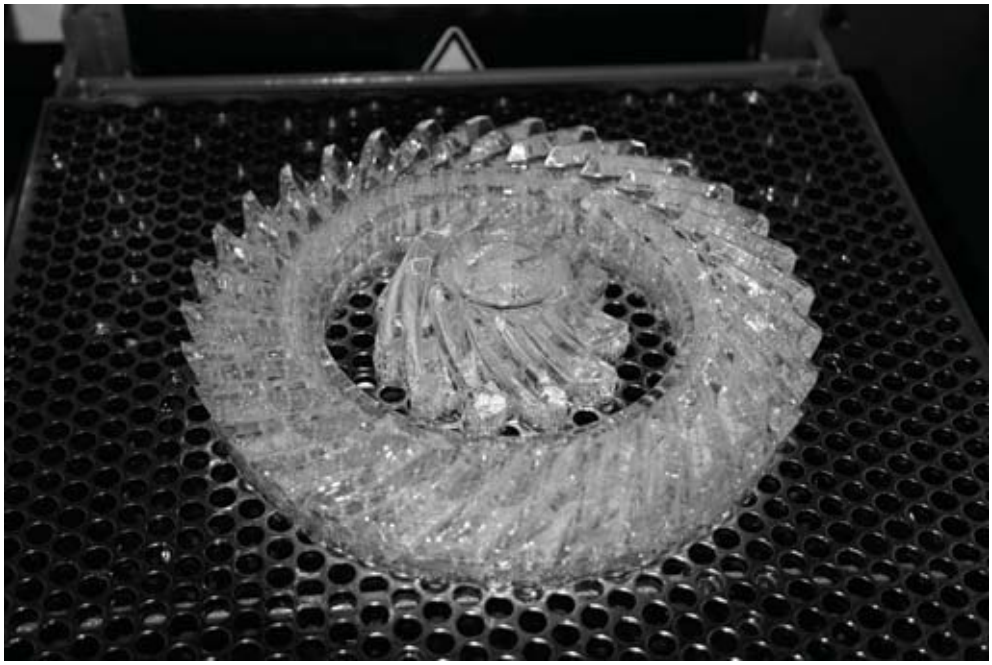

Fig. 2. Finished stereolitography SLA models in UV chamber of SLA-250

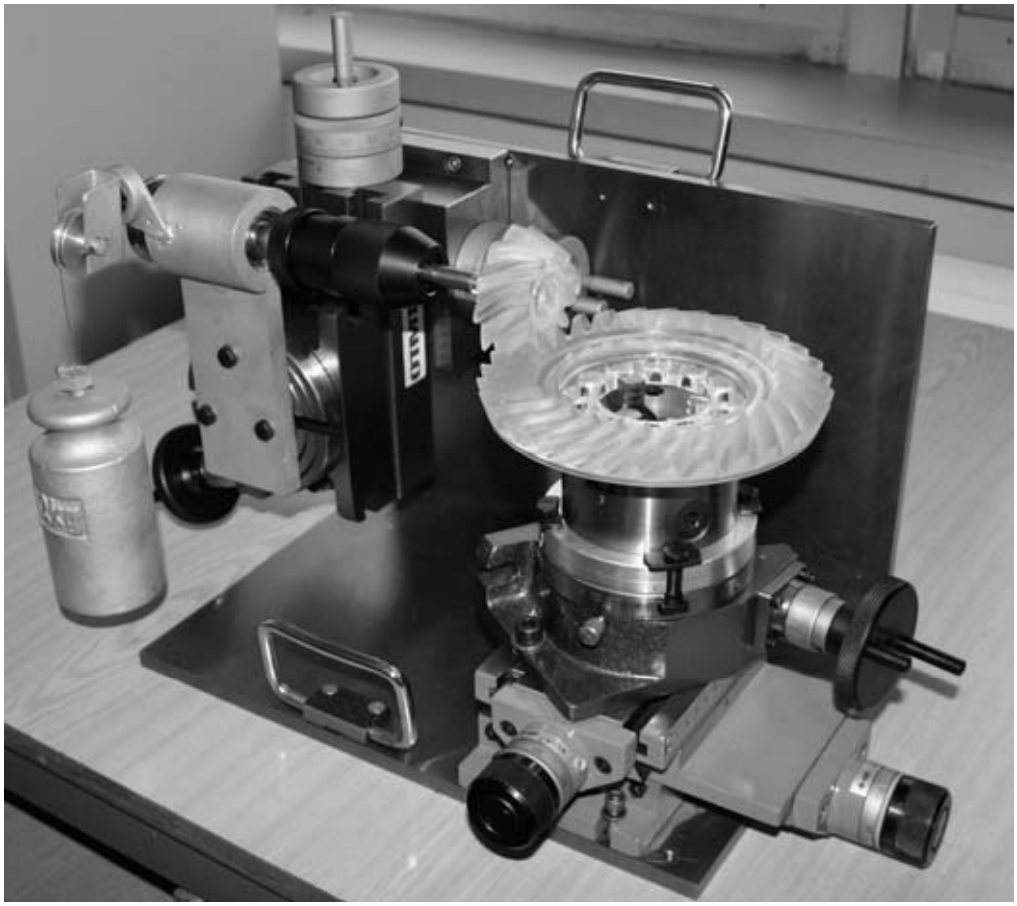

Fig. 3. View of testbed with gear pair

with gear's position in gear pair. One of gear is loaded with turning moment appointed using principle of model's similarity. This moment is such as a moment which is loading real gear pair

which is made of different material. The pinion is loaded by moment. The tooth contact can be observe directly (if gears are made of transparent material) or indirectly (using silicon cast).

3.1. Method of direct observation

There is a temporary tooth contact between teeth during loading of gear pair with moment. The testbed enables to gears' rotation in gear pair though rotation of one gear. It makes possible to direct observation of tooth contact's changes during rotation of loading gear. The observation is possible when the transparent material is used for gears (Fig. 4).

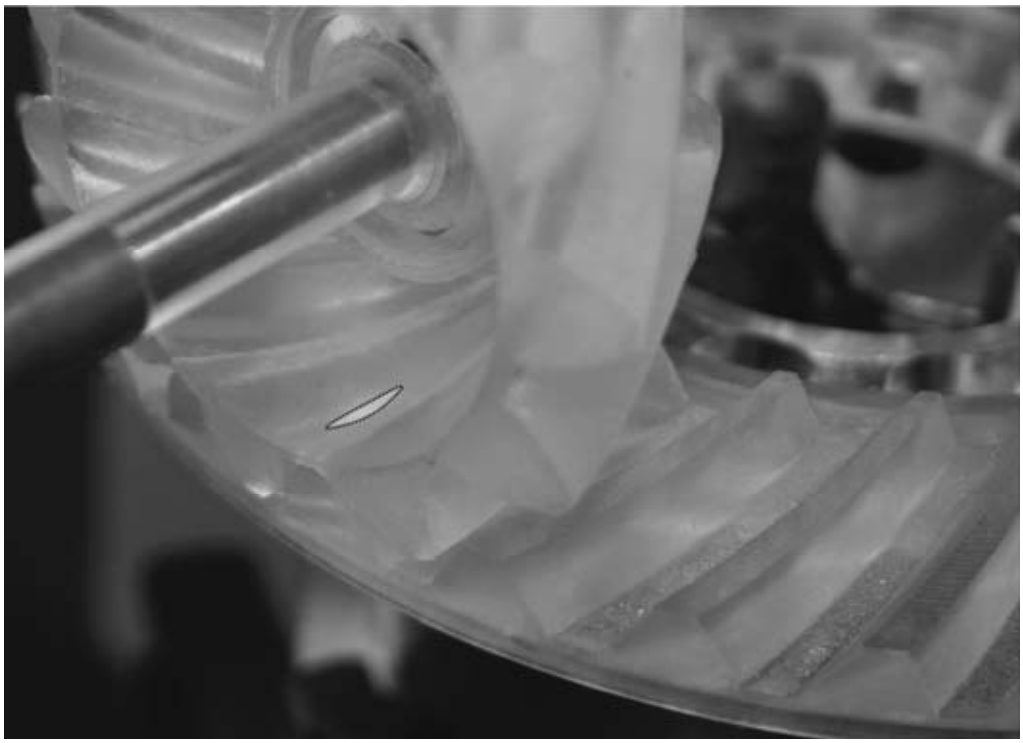

Fig. 4. Contact area (outline with dashed line) between teeth of loaded gear pair with moment

In the case of gears made of opaque material, there is in need of using the method of indirect deformation's freezing.

3.2. Method of indirect deformation's freezing in silicon

The temporary tooth contact can be indirect observed using technique of deformation's freezing. In order to do the observation is used the special container, which is being filled of silicon, when the gear pair is loaded (Fig. 5). The gears are in deflection state, so the setting silicon maps empty space between teeth. When the silicon has been set, the gears are removed from the testbed. Such material, which silicon is, is very easy to remove from teeth area (Fig. 6). In the place, where the temporary tooth contact has appeared, remains elliptical hole in silicon (Fig. 7). It is a mapping of tooth contact, which has appeared between pair of mating teeth.

In this method is used the out-gassed silicon, which characterizes "shape memory". It enables to indirect deformation's freezing of loaded gears with static moment.

4. Conclusions

In the paper was shown the method of deformation's freezing. The method can be used in determination of temporary tooth contact for gear pair with static load. It is possible to directly

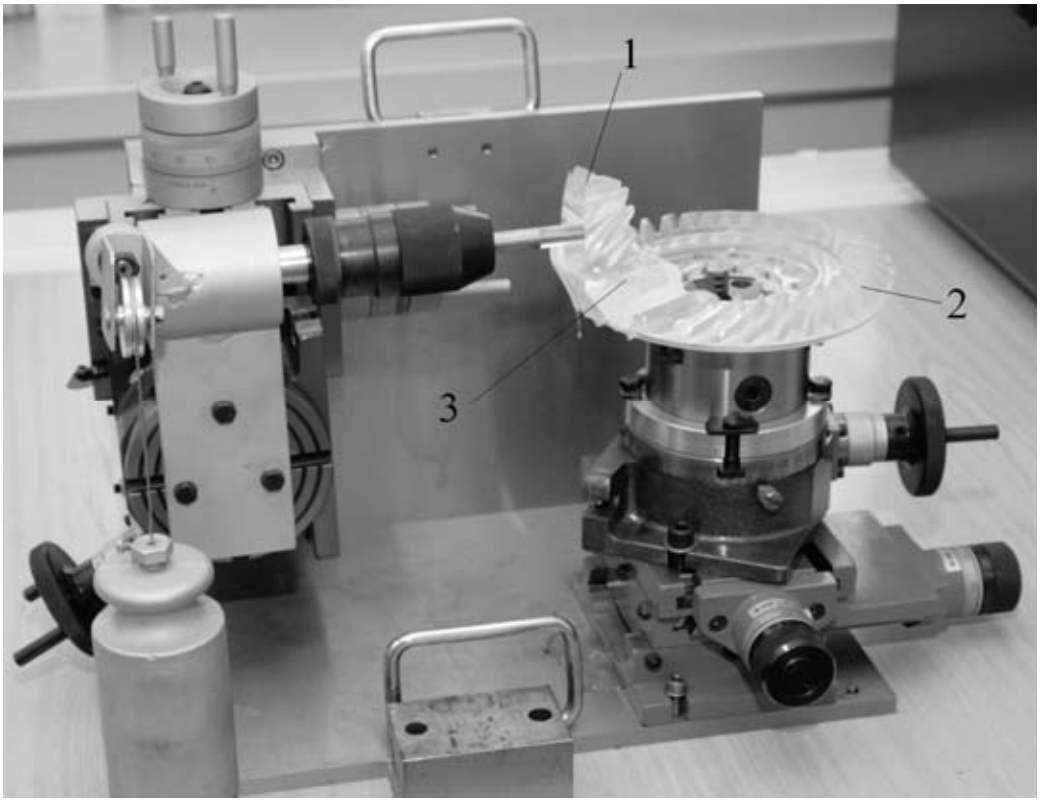

Fig. 5. Testbed with bevel gears: 1 – pinion, 2 – gear, 3 – container with silicon

Fig. 6. Silicon mapping tooth contact's area

observe contact area or – when gears are opaque – to indirectly observe. Using principle of model's similarity, the tooth contact in gear pair can be obtained. These methods enable to do preliminary qualitative analyse of correctness of new designing gear pair's working.

Additionally using one of Rapid Prototyping techniques in making of gear pair's model on the basis of CAD model, which is created using simulation of machining, eliminates costs connected with making physical, metal model by classic technologies.

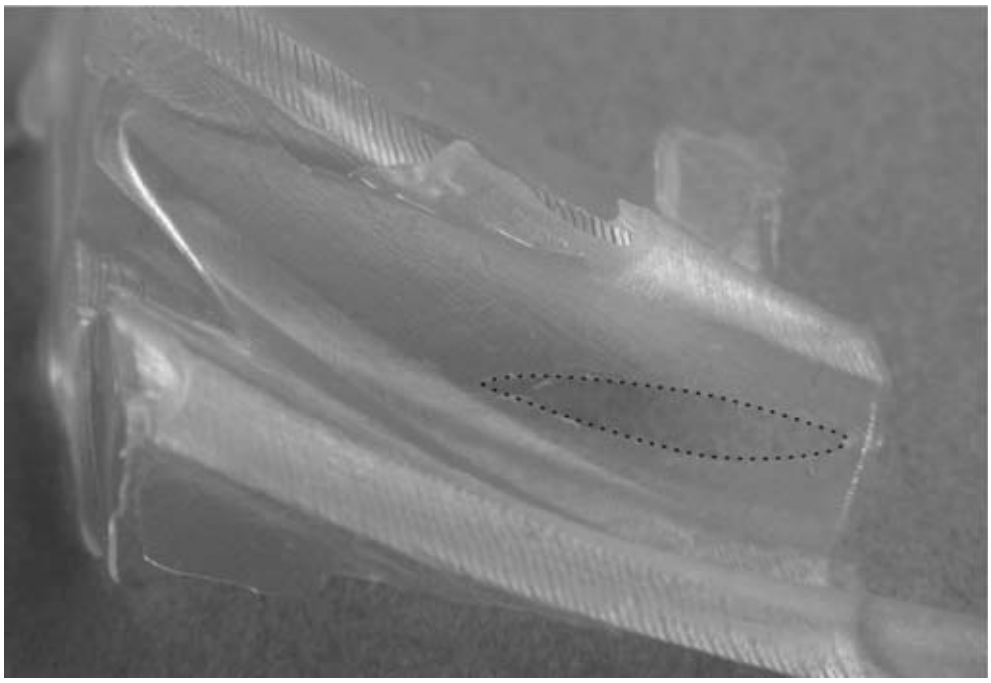

Fig. 7. Cut-out of silicon represented temporary tooth contact

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