QUALITY OF GEAR MESH AND ITS EFFECTS ON TRANSMISSION ERROR

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Abstract
This contribution shows the measuring results on the several involute gears. On every gear pair, actual gear mesh was assets based on its footprint and then transmission error was measured. Results of this measurements shows quality of contact, of involute gears and its effects on the transmission error of gears.

Key words: *transmission error; gear; gear mesh; footprint*

INTRODUCTION

The transmission error is generally considered to be indicator of overall gear quality. It's also closely related to the gear noise. Because its relation with gear quality it's also related with real contact conditions between tooths of gears. Contact condition between gears can be evaluated with knowledge of real total contact ratio. This can be determinate with footprint method. As you can see on Fig. 1 (Moravec, et al., 2009) contact ratio have quite good impact on gear noise and because of this it should also have impact on transmission error. Real contact ratio can differ from calculated one due to the manufacturing inaccuracies of gears and shafts, shaft bends, etc. This article will show how transmission error change with real total contact ratio of gears.

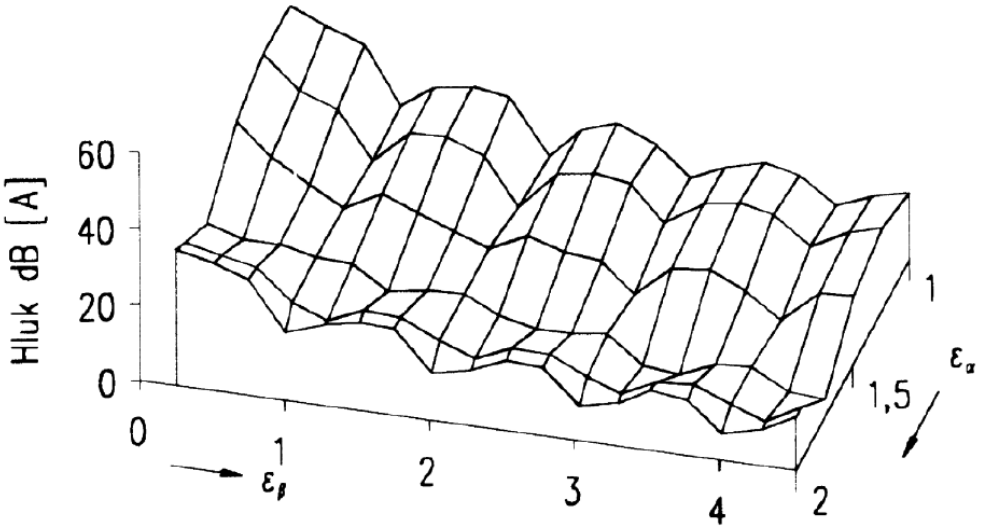

Fig. 1 Measured data

MATERIAL AND METHODS

Quality of gear mesh is evaluated with use of footprint method (*Pavlík, 2016*). This method is based on putting paint on gear and then under defined torque load made one spin of gear and take a look on the foot print that is made during contact of painted gears with other gear teeth. Example of these footprints can be seen on Fig. 2. Footprints are from same gear pair only different is in direction of load this mean in side of tooth's which are in contact together. On Fig.2 we can see that on one side is contact almost perfect bellow picture on Fig. 2 on the other side not so much top picture on Fig. 2. To make this footprints load of 50 N.m where applied on pinion gear.

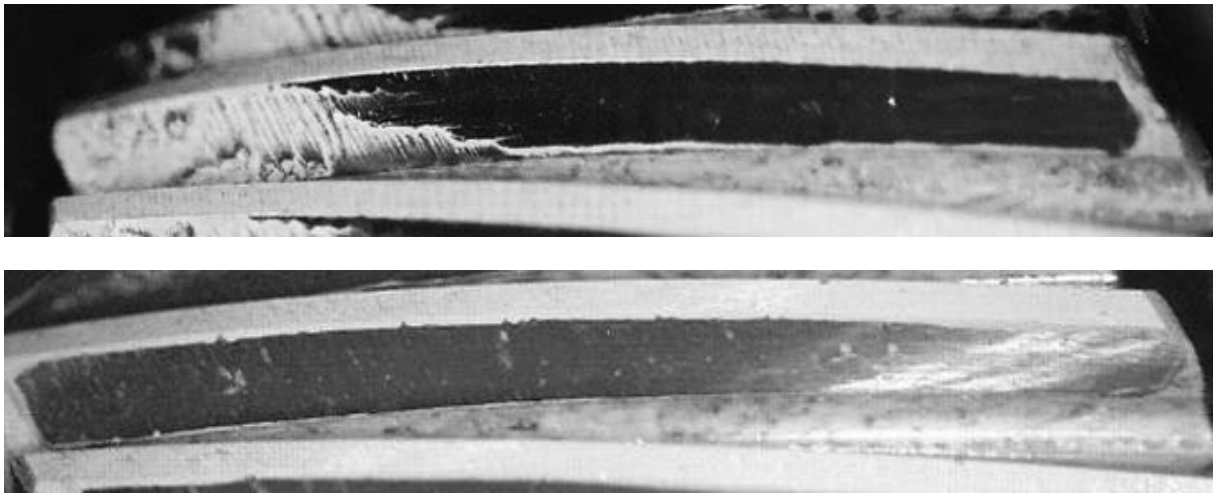

Fig. 2 Footprint of the gear pair 1

Real contact ratio was determinate by comparing areas of real contact and area of theoretical contact of gear using Autodesk AutoCAD software Fig.3. For gear pair on Fig.2 theoretical contact ratio is 4,48 this correspond with real ratio of contact on button picture on fig. 2. If we analyse real contact ration for contact on the top picture of Fig.2 than we get contact ratio 3,14.

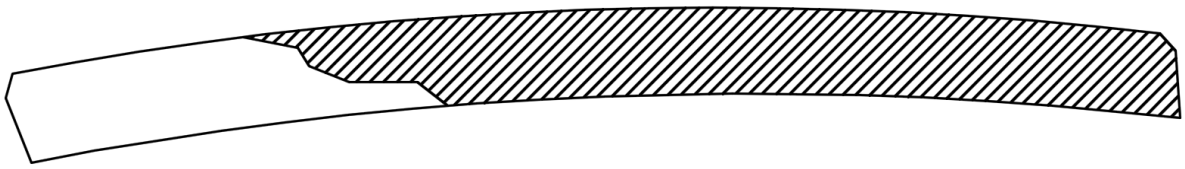

Fig. 3 Footprint area analysis

We recognize two types of transmission error, dynamic transmission error and static one (*Houser, Blankenship, 1989*). For the purposes of this article if transmission error is mentioned it mean dynamic transmission error. Difference between these two are in the condition of measurement. Static transmission error is measured with zero or very small RPM of shafts, dynamic TE its measured at relatively height speeds, basically as close to the real device as can be. As for the values of transmission error is evaluated with peak to peak method as shown on Fig.4.

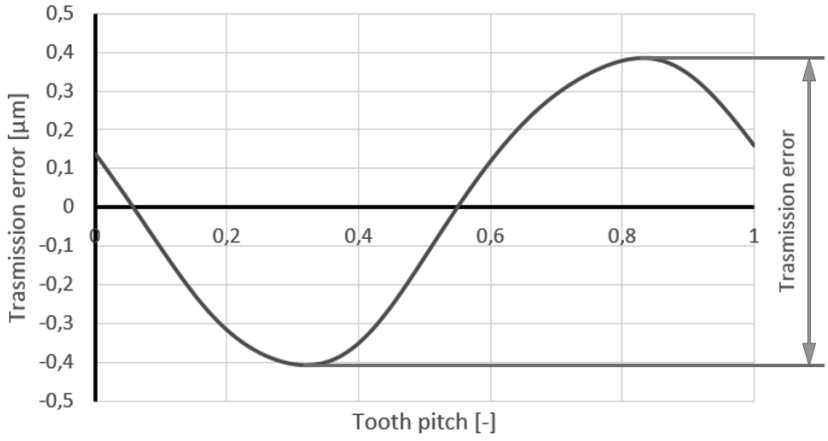

Fig. 4 Peak to peak transmission error

Transmission error measurement is performed by measuring angular position of each gear on not-loaded end of the shafts (*Mark, 2013; Tůma, 2014*) at testing device specially made for such measurement. Because transmission error is value that depends on a lot of parameters during measurements we must be sure to have same starting condition for measurement. To evaluate transmission error methodology was changed according to the latest finding. Change mainly consist of measurement setup and stabilization of measurement conditions and in the evaluation part of measurement the averaging of transmission error signals that is mention in (*Tůma, 2014*) is not used. But every contact of each tooth pair is evaluated individually and then these results are averaged to get the average transmission error.

RESULTS AND DISCUSSION

After measurement on 4 gear pairs (two pairs with CSN geometry and two with HCR) Fig.5. We got data in table 1 these shows total contact ration and measured transmission error.

Fig. 5 Pair of tested gears

Tab. 1 Measured data

Total contact ratio -	Transmission error µm	Total contact ratio -	Transmission error µm
4,48	1,113	5,37	0,682
4,48	1,091	5,37	0,552
3,34	1,452	3,38	1,159
3,34	1,211	3,38	1,279
5,37	0,616	4,48	0,906
5,37	0,544	4,48	0,954
3,29	1,167	3,45	1,421
3,29	1,539	3,45	1,220

Values from table 1 can be seen in graph on Fig.6. Here can be clearly seen that theory and measurement are alight. With increasing of the total contact ratio, transmission error is decreasing.

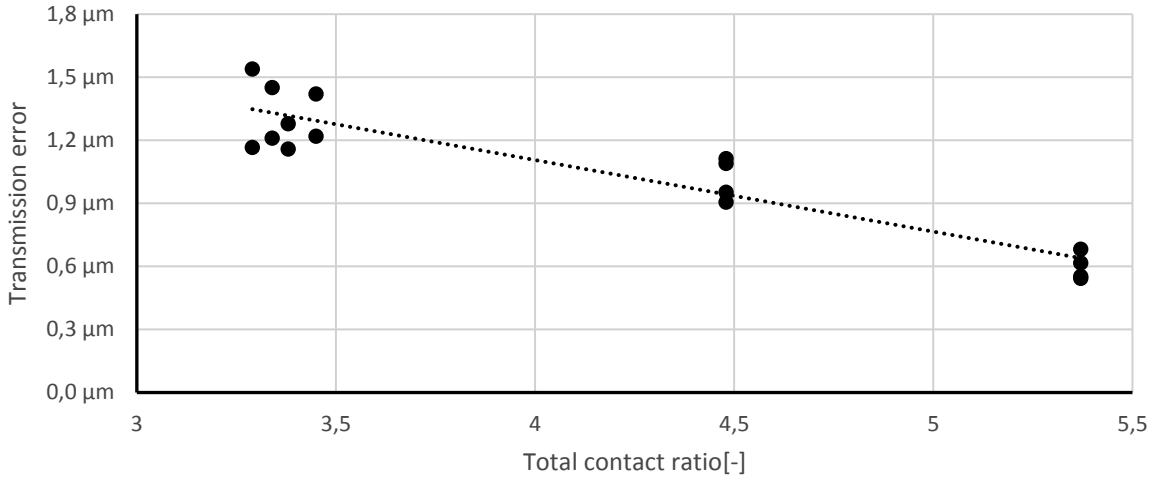

Fig. 6 Graph of Transmission error to total contact ratio

On Fig. 6 we can see that real contact ratio must be measured, because if we do not do this measurement we cannot be sure how good real contact between pairs of gears is. Contact ratios 4,48 and 5,37 corresponds with perfect contact of gears and its equal to design total contact ratio. Other values are calculated according to the area of real contact.

CONCLUSIONS

The noise and vibrations generated by gears, its topic that companies from automotive industry deals with on daily basis. Transmission error is indicator of overall gear quality and it seems that it is closely related to the many process that can occur during gear contact. In article, its shown how total contact ratio influence transmission error. From results of measurement we can say that at least for transmission error value bigger total contact ration its always better.

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