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The Case of Chevrolet Cruze Clutch Destruction and an Expert Procedure at Technical Analysis of Its Cause

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Abstract: ***The article deals with the issue of vehicle defect´s technical assessment. It points out an importance of technical expertises for courts´ work and expertises of technical experts. Technical defect presented - Chevrolet Cruze vehicle clutch failure and resulting technical assessment of its occurrence cause is unique due to the fact that this defect has been repeated and by comparing the characteristics of damage to the individual parts from submitted documentation and photographic documentation it was possible to carry out a defect analysis. Technical expert´s procedure description and the result of his investigation are listed.***

Keywords: Automobile, fault, repair, legal proceedings, technical expertise, engine clutch, technical expert, investigation

1. Introduction

For courts´ decision, there is often a need for a technical assessment of subject of the case. For this purpose, the court invites a technical expert who is professionally competent to assess the case from a technical standpoint. The preparation of technical experts to carry out such tasks requires, besides knowledge, continuous knowledge of procedures and results of the technical expertise already carried out, which is necessary in time of the current dynamic development of automotive technology. This article aims to clarify the procedure for conducting technical expertise and its conclusions, as technical analysis carried out to identify the cause of vehicle´s defect is one of the most challenging tasks for a technical expert. In order for an expert to assess the cause of a vehicle defect, he must know the design, repair technology, recommended process of vehicle repair and other operational technical characteristics of the vehicle in relation to the vehicle group in question. Difficulty of task increases when the expert does not have possibility of directly assessing damaged parts, e.g. if the expertise takes place over a long period of time since the expertise is preceded by a lengthy dispute between the parties, one of which is the vehicle owner and the other is service station and dealer. The presented analysis of clutch's destruction cause was made for the purposes of court proceedings in which it was necessary to decide whether the defect in question of Chevrolet Cruze at 11/2012 was due to the owner's way of driving or as a result of parts´ destruction during the vehicle´s warranty period. Significant and unique, it can be assumed that there was a repeated failure of the clutch in 03/2016 and it was therefore possible to compare the characteristics of damage to the individual parts and also to draw technical conclusions based on this comparison. It should also be pointed out that the vehicle has become a dangerous means of transport as a result of the defect in question and that the defect in question may have led to a traffic accident as a result of reduced ability to fully control the vehicle in accordance with operational circumstances.

2. Found Circumstances to the Case

In this case, it was a matter of assessing the occurrence of clutch destruction on the Chevrolet Cruze vehicle shown in Fig. 1

Figure 1: Chevrolet Cruze vehicle

The following information on the vehicle and its repairs was provided to the technical expert:

The vehicle was bought in the year 2010 and the following guarantees were provided by seller:

- Bodywork guarantee: 6 years
- For the other vehicle parts 3 years or 100,000 km

The following repairs were performed on the vehicle (repair date and mileage indicated):

05/2012 (108 100 km)	-	replacement of the main clutch cylinder, vehicle taken into service
09/2012 (124 500 km)	-	service inspection, found sleeve damage, clutch pedal does not return (deaeration of clutch hydraulic system)
10/2012 (128 845 km)	-	replacement of the damaged sleeve, clutch pedal does not return occasionally
11/2012	-	clutch failure and its repair (replacement: clutch master cylinder, clutch slave cylinder,

clutch disc with facings, pressure plate, flywheel)

03/2016(218 216 km) - clutch failure and its repair (replacement: clutch master cylinder, clutch slave cylinder, clutch disc with facings, pressure plate, flywheel)

Provided photo documentation of parts´ damage

Photo documentation of condition of parts exchanged during the repair performed in 11/2012 is shown in Fig. 2

Figure 2: Selection of photo documentation of damaged parts of the vehicle after repair from 11/2012

Photo documentation of condition of parts exchanged during the repair performed in 03/2016 is shown in Fig. 3

Figure 3: Selected photo documentation of damaged parts of the vehicle after repair from 03/2016

3. A Description of the Chevrolet Cruze Clutch Group Function

The clutch is part of the motor drive and is located between the engine and the gearbox.

Function of clutch is to disconnect and connect transmitted driving torque from engine to control the vehicle at start-up time, gear shifting, and stopping the vehicle [1].

In this case, it is a friction clutch which has a pressure plate with a membrane spring and a flywheel in action on the clutch disc (friction facings). Clutch control is performed by a hydraulic transmission consisting of a clutch master cylinder operated by clutch pedal, hoses and a clutch slave cylinder that controls the clutch bearing. It is possible to consider the engine's flywheel as its functional part [2]. Chevrolet Cruze is powered by a dual-mass flywheel.

Diagram of clutch with membrane spring function is shown in Fig. 4

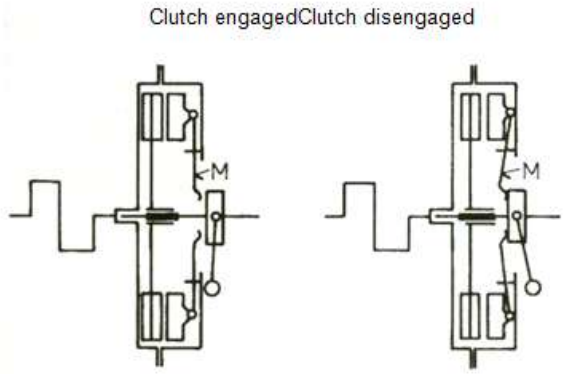

Figure 4: Shows the function diagram of clutch with membrane spring [1]

Chevrolet Cruze pedal group is shown in Fig. 5

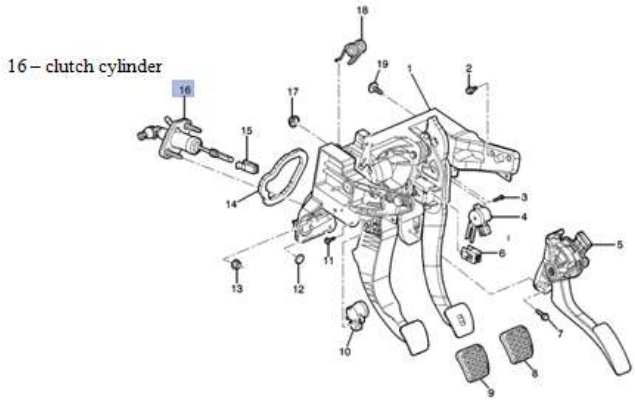

Figure 5: Shows the Chevrolet Cruze pedal group

4. Dual-mass flywheel - brief explanation and description of characteristics

The dual-mass flywheel acts as a normal flywheel that additionally performs the torsional vibration damping function and largely eliminates unwanted vibration and noise. The dual-mass flywheel is different from the classic by that its main part - flywheel - is coupled with the crankshaft flexibly. Therefore, in a critical phase (before the

peak of compression), some deceleration of the crankshaft can be achieved, and then some acceleration (in expansion). However, the speed of the flywheel itself remains constant, so the output speed to the gearbox is constant and vibration free. The double-mass flywheel linearly transfers its kinetic energy to the crankshaft, the course of reaction forces on the engine itself is smoother and the peak values ??of these forces are far lower, so the engine is less vibrant and less vibrating the rest of the bodywork. By splitting into the primary inertial mass on the engine side and the secondary inertial mass on the gearbox side, the moment of inertia of the gear unit´s rotating parts increases. This translates area of resonance into the area of lower frequencies (revolutions) than idle speed revolutions are and they do not lie in the area of ??operating engine speed. Thus, the torsional vibrations generated by the engine separate from the gearbox and the transmission noise and bodywork rumbling are no longer present. Thanks to the primary and secondary parts connected with torsional vibrations damper, it is possible to use a clutch disc without torsional coil springs. The dual-mass flywheel also serves as a so called shock absorber. This means that it helps to soften the shocks on the clutch when shifting (when it is necessary to equalize engine speed with the speed of wheel) and also helps to make a more smooth start-off. However, the spring elements are continuously weared out in dual-mass flywheel and allow the flywheel to move more and more easily towards the crankshaft. The problem occurs when they are already worn out - drawn completely. By wear down of the flywheel, it is meant, in addition to drawing the springs, that the holes are pushed out onto the stop pins. Thus, the flywheel not only does not damp vibrations, but produces them. Stops to the extreme limitation of the flywheel turning begin to appear, most often as knocks when shifting, starting, simply in all situations where the clutch engages or disengages or when rpm is changed. Wearing out will also begin to appear as jerky start-offs, excessive vibration and noise around 2000 rpm or excessive idling vibration. Generally, there are much more stressed dual-mass flywheels with motors with less cylinders (e.g. three / four-cylinder), where the irregularity of run is much greater than in the six-cylinder aggregate..

Following the construction page, the dual-mass flywheel consists of a primary flywheel, a secondary flywheel, an internal damper disc, and an external damper disc as shown in Fig. 6.

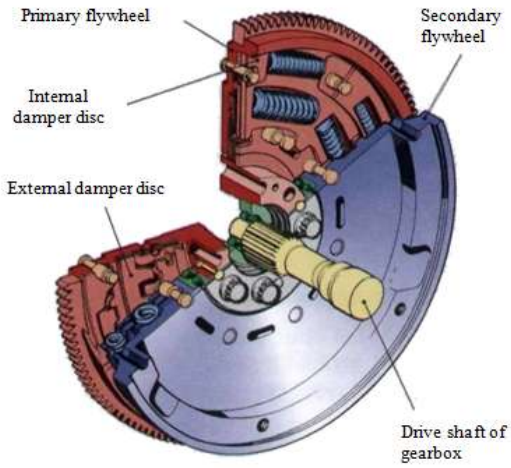

Figure 6: Illustrative view of the dual-mass flywheel [1]

The lifespan of the flywheel is affected by its design as well as the characteristics of the engine into which it is being implemented. The same flywheel from the same manufacturer can do 300,000 km with some engine and with other one fails already after half a mileage. The original intention was also to propose dual-mass flywheels that would live the same age (mileage) as the entire vehicle. The reality is often that the flywheel has to be replaced much earlier, many times rather than the clutch disc. In addition to the design of the engine and the dual-mass flywheel itself, the driver has a significant impact on its lifespan. All situations that lead to shocks in one way or the other shorten its lifetime.

In order to extend the lifespan of a dual-mass flywheel, it is often advisable not to drive the engine with low rpm (especially below 1500 rpm), do not release the clutch fast (if possible, without kicks while shifting), and not to shift lower gear with the engine at too high rpm. (that means brake with engine only at adequate speed, in order to avoid that at the speed of 50 mph you would often have the second gear, but rather the third or fourth and gradually lowering it to lower). Some manufacturers have recommended that if you park with a standing vehicle on a slight hill, first you have to apply the handbrake and then shift the gear (return or 1st gear). Otherwise, the vehicle moves slightly and the dual-mass flywheel gets into the so-called constant gear, thereby is straining (drawing the springs).

So it is recommended not to set the speed in the hill, and if so, only with the vehicle braked by handbrake to prevent small movement and consequent long-term loading - stopping of the transmission system, thus also a double-mass flywheel. Shortening of the two-mass flywheel´s lifespan is also directly linked to the increasing clutch disc temperature. The clutch is overheated especially when pulling a heavy trailer or a second vehicle, riding in terrain, etc. It should be noted that radiant heat from the clutch disc overheats various flywheel components (especially in case of lubricant, that will leak), which further affects the lifespan negatively.

5. Failure on a dual-mass flywheel

In addition to operating signs (slipping, dragging), there is a risk of loosening and possibly separating a part of the flywheel, most often causing the friction surface released and deflected, resulting in excessive unilateral wear of the facing. In addition to the destruction of the flywheel itself, the engine or gearbox may be fatally damaged as well. Excessively worn flywheel also affects the correct function of the crankshaft speed sensor. By gradually wearing down the spring elements, both parts of the flywheel deflect more and more until they get out of tolerance of preset values in the control unit. Sometimes it results in an error message, and sometimes it tries to adjust the controller and, based on bad data, operate the engine. This results in a deterioration of the operating properties and, in worse case, in the problems with startup. This problem concerns mainly older engines where the crankshaft sensor detects movement on the output side of dual-mass flywheel. Manufacturers have eliminated this problem by changing the sensor's position, so in newer engines, the crankshaft speed is measured at the flywheel input.

Clutch damage analysis on the Chevrolet Cruze vehicle

10/2012	03/2016
clutch disc with facings	
surface in contact with flywheel 	surface in contact with flywheel 
surface in contact with pressure plate 	surface in contact with pressure plate not documented
flywheel friction surface - nature of damage  	

6. Evaluation of detected damage according to photo documentation

Clutch disc with facings (slats)

Figure 7: Indication of identical characteristics of clutch disc damage

Damage on the photo documentation from 11/2012 is virtually the same as damage on the photo documentation from 03/2016, and it can be assumed that they were caused by the same cause - defect of the dual-mass flywheel as apparent greater wear of one side (from the side of flywheel) than of the other side (from the side of pressure plate) can not be technically interpreted except that the flywheel surface has been released and pressed against the facing also in time when the clutch was disengaged as well as the pressure on the side of flywheel was not uniform. Pressing on the flywheel surface even when the clutch is disengaged lawfully leads to transmission at this time and the clutch acts so that it does not completely disconnect the engine from gearbox, leading to poor chanching of gears. This phenomenon forces driver to use an increasing power to control the clutch in order to disengage and in this way cause abnormal pressure on the mechanical parts of the pedal group, resulting in minor deformations that are not detectable. Also, damage to the gearbox's radial shaft seal can be seen as a result of heat and mechanical stress resulting from faulty flywheel, since uncontrolled friction between clutch disc and flywheel produces excessive heat, which is mainly apparent on reduced lifespan of the rubber parts in question.

Flywheel Friction Surface

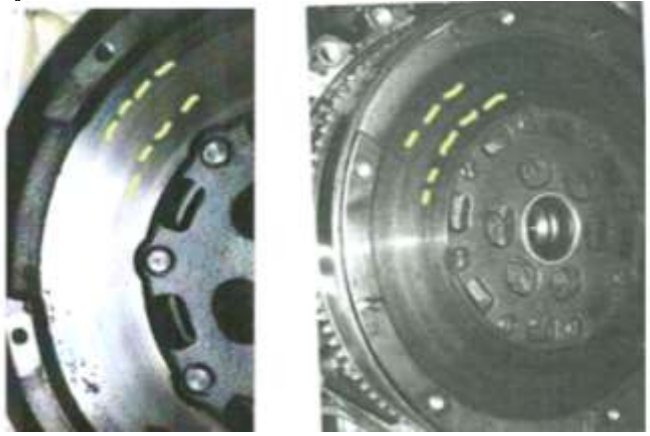

Figure 8: Indication of identical characteristics of damage to the flywheel impact surface

Damage on the photo documentation from 11/2012 is virtually the same as damage on the photo documentation from 03/2016 and it can be assumed that they were caused by the same cause, i.e. by failure of dual-mass flywheel as a result of way the vehicle was operated.

Pedal Group

During repairs in 2012 and 2016, the pedal group has not been changed, nevertheless the vehicle has been put into serviceable state, i.e. the brake pedal has returned and therefore mentioned fault can only be considered as a consequence of a clutch failure, dual-mass flywheel respectively.

7. Conclusion

Taking into account that in 11/2012 all the damaged active parts of the clutch were replaced and that there was an identical defect in the clutch of Chevrolet Cruze vehicle in 02/2016, it can be concluded that the clutch failure of the vehicle was due to way of its operation, the reported failure (clutch pedal did not return) is not considered to be the cause of the fault but as a consequence, since no part of the pedal group has been changed during any of the repairs performed. The presented procedure has been recognized as convincing, in particular in comparison to conformation of characteristic damage of the individual parts that has been demonstrated.

8. Acknowledgment

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