List of research topics
Department of Vehicle Elements and Vehicle-Structure Analysis (2018.09.13)

1. Mechanics and vehicle structures

1.1. Shiftability of vehicle gearboxes

These days the automated manual transmissions (AMT) become more and more popular in Europe. During the gearshift, the engagement of the gears is realized by a synchromesh system, whose core is a spline clutch. The shiftability of a spline clutch depends on many properties of the gearbox and the actuating system. Three main subsystems must be studied in details: the gear system in the gearbox, the actuating system and the transmission of the power from the gearbox to the wheels. These systems have main influence on spline clutch shiftability.

Depending on the level of approach, the following studies are proposed:

- Study of wear of spline edges
- study of conditions for shiftability
- effect of gearbox architecture on shiftability
- requirements for actuators depending on gearbox architecture
- definition of minimal sensor number for gear change control

Levels of approach:
BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: László Lovas

1.2. Study of wheel bolt loosening

In Hungary, upon statistics two bus or truck wheels roll away from the moving vehicle each month. Both the freely rolling wheels and the uncontrollable heavy vehicles are very dangerous in the traffic. Usually, the wheels roll away because of the automatic self-loosening of the wheel bolts.

Depending on the level of approach, the following studies are proposed:

- study of friction on thread and under the bolt head with loads of different orientation and time dependent loads
- study of bolt and nut deformation with loads of different orientation and time dependent loads
- study of the unscrewing mechanism of a loose nut

Levels of approach:
BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: László Lovas
1.3. Validation of vehicle parts finite element models

The finite element model of an assembled structure is representative of the real structure only if each constitutive part is validated. This validation is very important in the case of dynamical simulations.
In such cases dynamics of real parts are studied experimentally, and dynamical parameters are measured. Measurement results are compared to those extracted from simulations. If measured and simulated parameters are close enough, then the part is validated. If the measured and simulated parameters are sensibly different, that the finite element model has to be corrected till the simulated dynamical parameters are close enough to the measured ones.
Depending on the level of approach, the following studies are proposed:

- Elaboration of experimental measurement methods
- Methods for comparison of measured and simulated parameters. Detection, localisation and parametrisation of differences
- Realisation of experiments to modify the structure dynamics of finite element model

Levels of approach:
BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Ferenc Pápai

1.4. Damping mechanism identification of vehicle part materials

Study of rheological models. Modelling material properties. Identification of damping mechanisms. Model parameter identification based on experiments. Link between the parts rheological model and dynamical characteristics. Dynamical modelling of parts made from non metallic material (polymer), based on measurements, application of model parameters in finite elements analysis.

Levels of approach:
BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Ferenc Pápai

1.5. Structure diagnostics and monitoring


Levels of approach:
BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Ferenc Pápai
1.6. Nonlinear waves in traffic systems

In a flow of vehicles the braking or acceleration of a given vehicle spreads wavelike in the system. The fact of spreading, depending modelling of the driver’s behaviour can lead to traffic jam like structure that in some cases also spreads as a wave. Such phenomena can be described with a special wave type phenomenon called soliton. Goal of the research is the deeper understanding of the phenomenon to improve the traffic control. Depending on the level of approach, the following domains can be studied:

- vehicle flow as dynamical system,
- role of a simple driver model,
- recursive and anticipatory systems,
- nonlinear phenomena.

Levels of approach:
   BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Peter Béda

1.7. Mechanical modelling of non-local materials

There is an emerging need to apply material models taking into consideration non-local properties in the case of modern structural materials. Building and handling of these models as well as elaboration of the needed experimental methods are important tasks. The materials in question are composites, macromolecular polymers, or nanomaterials like graphene, carbon nanotubes, etc., where it is important to model non-local effects of the nano structures.

Depending on the level of approach, many domains can be studied:

- internal material length, models of gradient materials
- application of fractional calculus
- study of non-locality in space or time
- linear and nonlinear stability problems
- handling of discrete-continuum model transitions

Levels of approach:
   BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Peter Béda
2. Biomechanical research

2.1. Cooperation between cranial bone and implant

It is a common practice in neurosurgery to remove a part of the cranial bone, due to external injury or in order to get access to the brain. After partial recovery of the patient, the missing bone part must be covered. The cover is usually made by implants manufactured via CAD/CAM technology. The fixations of the implants and also the cooperation of the cran and the implant during shape modification due to bone growth are very interesting and important domains.

Depending on the level of approach, the following domains can be studied:

- study of bone and bolt cooperation
- study of implant and bolt cooperation
- study of bone-bolt-implant triplet cooperation
- implant shape transformation in time, under external load
- effect of manufacturing technology on implant price and shape quality

Levels of approach:
- BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: László Lovas

2.2. Finite element analysis of a tibia

In case of tibia implants, it is of great importance to dimension them mechanically. Accurate modelling, definition of deformation and stress fields are realized through finite element simulations. To perform such simulations, loads on the bone, the mechanical fixations, and bone material parameters have to be known in detail. It is also necessary to extract a CAD model easy to handle from CT records, that is not obvious.

Levels of approach:
- BSc diploma thesis, MSc diploma thesis, PhD research

Responsible: Peter Ficzere
3. 3D printing linked research

3.1. Material study of soft PLA

The PLA is a good quality plastic made from corn amidon. It is a largely used material in FDM printers due to easy printability and good surface quality. No heated platform is needed to the printing. The soft PLA material filament has extremely high flexibility and is softer than rubber. It is ideal to make gaskets and other elastic parts.

The goal of the research is to determine material properties depending on printing parameters (printing speed, temperature, layer thickness, etc.).

Levels of approach:
- BSc diploma thesis, MSc diploma thesis, PhD research

*Responsible: Peter Ficzere*

3.2. Material study of Colorfabb BronzeFill Filament

This material can be applied to FDM printers. It contains bronze and is electrically conductive.

One goal of the research is to find the optimal printing parameters. Other goal is to determine material properties depending on printing parameters (printing speed, temperature, layer thickness, etc.).

Levels of approach:
- BSc diploma thesis, MSc diploma thesis, PhD research

*Responsible: Peter Ficzere*