2. Research methodology

In the study, we consider the system as depicted in Fig. 1. The carrying structure or railway track is represented by one or two parallel spans. For the spans, the Euler-Bernoulli beam model is adapted.

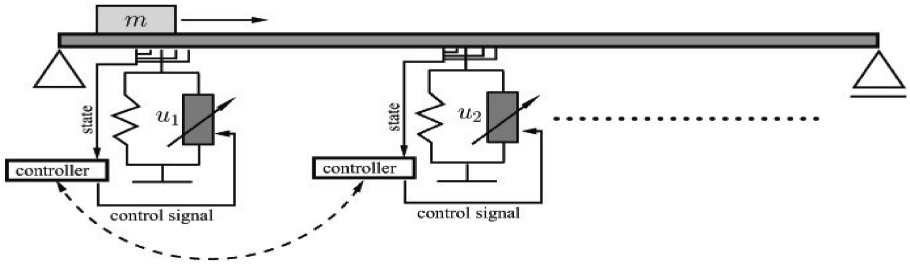

Fig. 1. A span supported by a distributed semi-active control architecture.

The beam is supported by a set of controlled supports (perceived as a set of modules). For control objective, we combine the smooth passage with reduced beam deflections. For control parameters we assume both damping and stiffness parameters. Eventually, the variable stiffness are meant to be approximately realized by relevant non-linear springs. Each of the supports is equipped with a controller that receives the information of its local state. It is also allowed to communicate with other controller or controllers under a relevant minimal communication topology (to be determined). Thus, the optimal controller decision is based on its local state and also on the information provided by the other controller (or controllers). The information arriving from one of the previous modules will be also triggering the controller to update his optimal decision. This must be done in advance, since the process of optimization takes some time and the optimal decision is supposed to be applied at the right time, i.e. when a load is passing the section corresponding to the controller. Therefore, at this stage two major problems are addressed. The first one is to find a proper controller communication topology taking into account performance, but also computational capabilities and simplicity in practical realization. The second one is to design a feedback structure for each of the controllers and a method that allows them to update the optimal decision in a reasonably short time. To solve these problems, analysis of controllability of distributed systems is performed and the methods of real-time optimization (based on the receding horizon control [5]) are applied. The analyzed model is represented by the following bilinear system of ODEs:

$$\dot{x} = A(t)x + \sum_{i=1}^{m} u_i B_i(t)x + F(t), \tag{1}$$

where x, u and F stands for the state, the set of control input and the travelling load excitation, respectively. The experimental validation of the proposed control method will be carried out by using the test stand operating in the Institute of Fundamental Technological Research.

References

1. Sh.J. Dyke, D. Giraldo (2002). Control of an elastic continuum when traversed by a moving oscillator, *Journal of Structural Control and Health Monitoring*, **14**, 197–217.
2. D. Pisarski, C. Bajer (2010). Semi-active control of 1D continuum vibrations under a travelling load, *Journal of Sound and Vibration*, **329**, 140–149.
3. D. Pisarski, C. Bajer (2010). Smart suspension system for linear guideways, *Journal of Intelligent and Robotic Systems*, **62**, 451–466.
4. C. Bajer, R. Bogacz (2000). Active control of beams under moving load, *Journal of Theoretical and Applied Mechanics*, **8**, 523–530.
5. Y. Wang, S. Boyd (2010). Fast Model Predictive Control Using Online Optimization, *IEEE Transactions on Control Systems Technology*, **18**, 267–278.