

II INTERNATIONAL CONFERENCE
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«Metrological Support of Innovative Technologies» ICMSIT-II 2021

«On a task of designing an object of cyber-physical quality control system for asphalt concrete mixtures compaction»

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Problem statement

- **The digitalization and intellectualization of road construction processes.**
- Non-destructive control of road surface compaction.
- In road construction, intelligent compaction, continuous compaction control, and neural network control system for pavers have been used



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Solution methods

Mathematical model in the state space

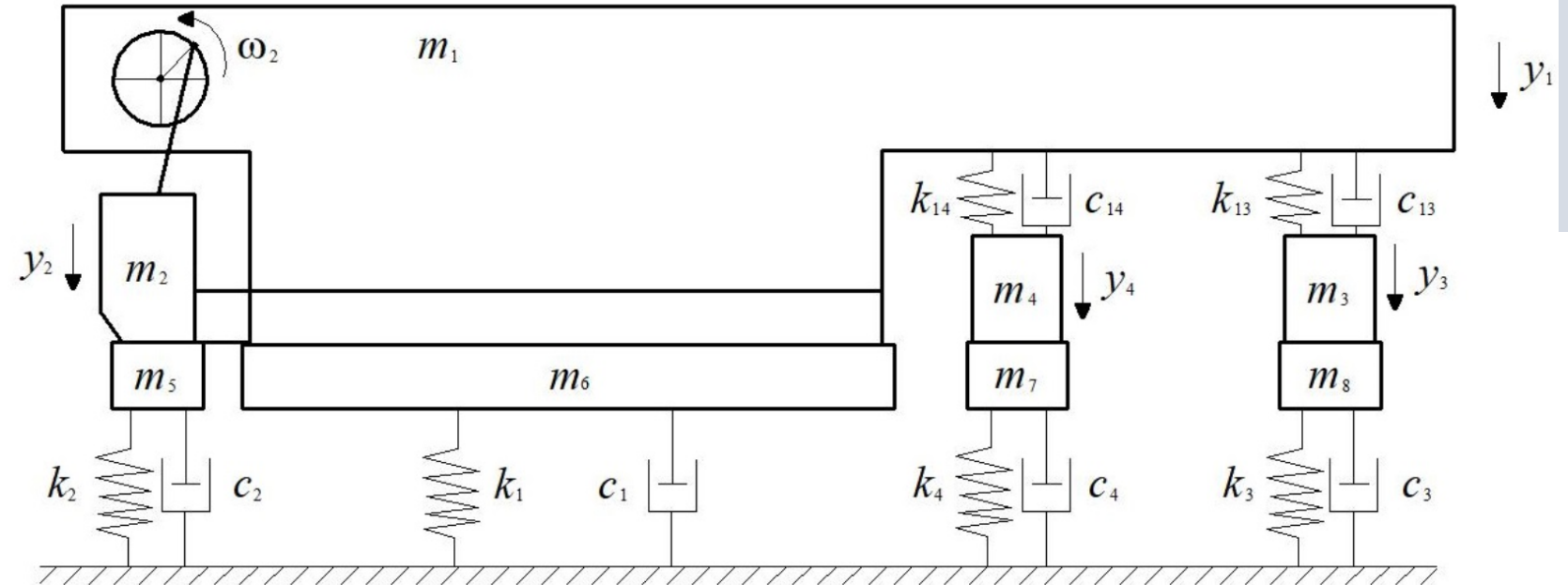


Figure. Dynamic model of the mixture compaction process by the working body (tamper, plate, two pressure bars) of the paver



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Solution methods

The system of equations is reduced to a system of first-order differential equations in the Cauchy normal form:

$$x_2 = \dot{y}_1; \dot{x}_2 = \frac{\left[\begin{aligned} &-(c_1 + c_2 + c_{13} + c_{14}) \cdot x_2 + c_{13} \cdot x_4 + c_{14} \cdot x_6 + (k_1 + k_2 + k_{13} + k_{14}) \cdot x_1 \\ &+ k_{13} \cdot x_3 + k_{14} \cdot x_5 - F_3 - F_4 + ((m_2 + m_5) \cdot e \cdot \omega_2^2 - k_2 \cdot e) \cdot \sin(\omega_2 \cdot t) \\ &+ c_2 \cdot e \cdot \omega_2 \cdot \sin(\omega_2 \cdot t + \pi/2) + (m_1 + m_5 + m_6) \cdot g \end{aligned} \right]}{m_1 + m_3 + m_6 + m_7};$$

$$x_6 = \dot{y}_4; \dot{x}_6 = \frac{1}{m_3 + m_8} \cdot (c_{13} \cdot x_2 - (c_3 + c_{13}) \cdot x_6 + k_{13} \cdot x_1 - (k_3 + k_{13}) \cdot x_5 + F_3 + (m_3 + m_8) \cdot g);$$

$$x_8 = \dot{y}_5; \dot{x}_8 = \frac{1}{m_4 + m_7} \cdot (c_{14} \cdot x_2 - (c_4 + c_{14}) \cdot x_8 + k_{14} \cdot x_1 - (k_4 + k_{14}) \cdot x_7 + F_4 + (m_4 + m_7) \cdot g).$$

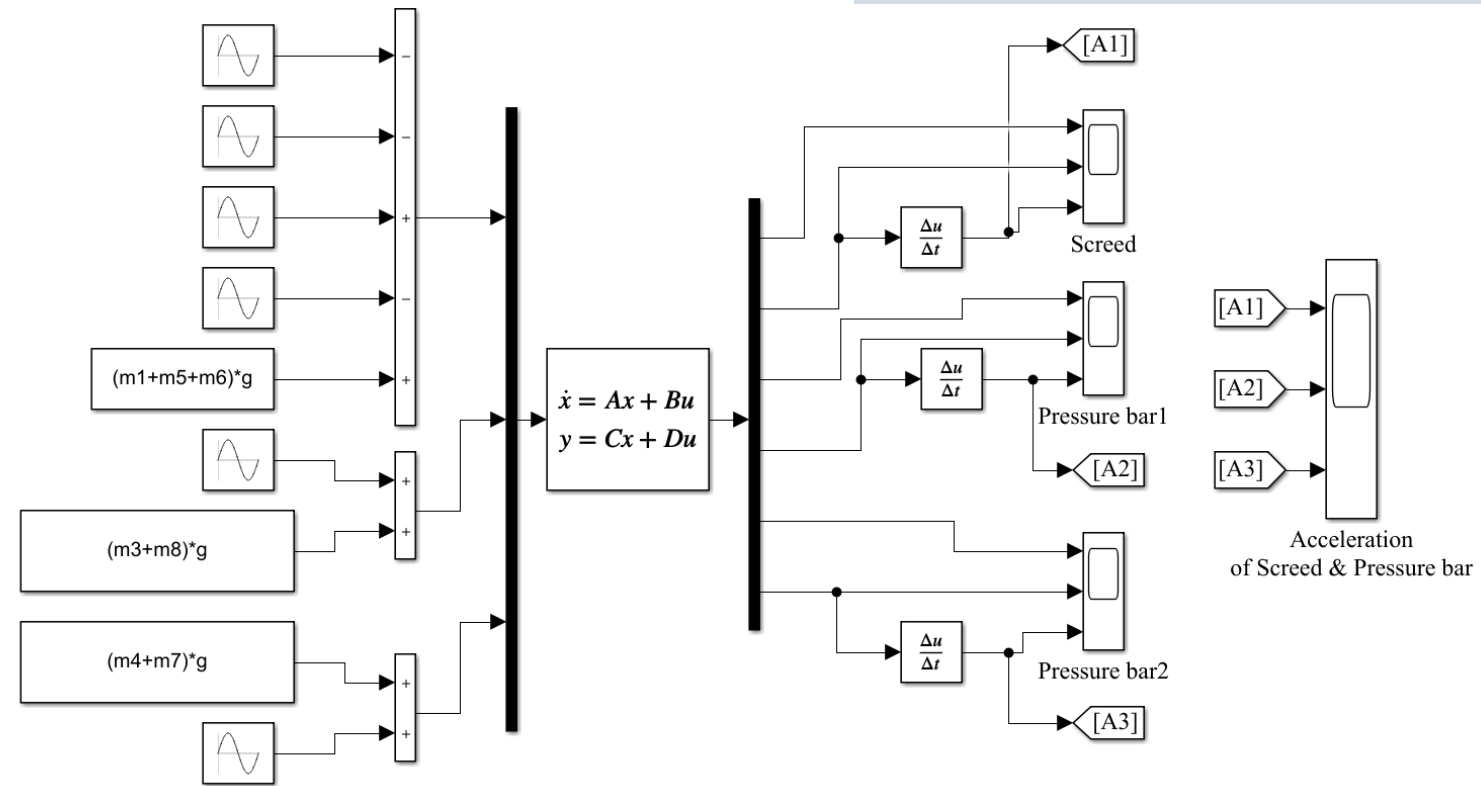


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Solution methods

Simulation model in MATLAB / Simulink



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Solution methods

Modeling

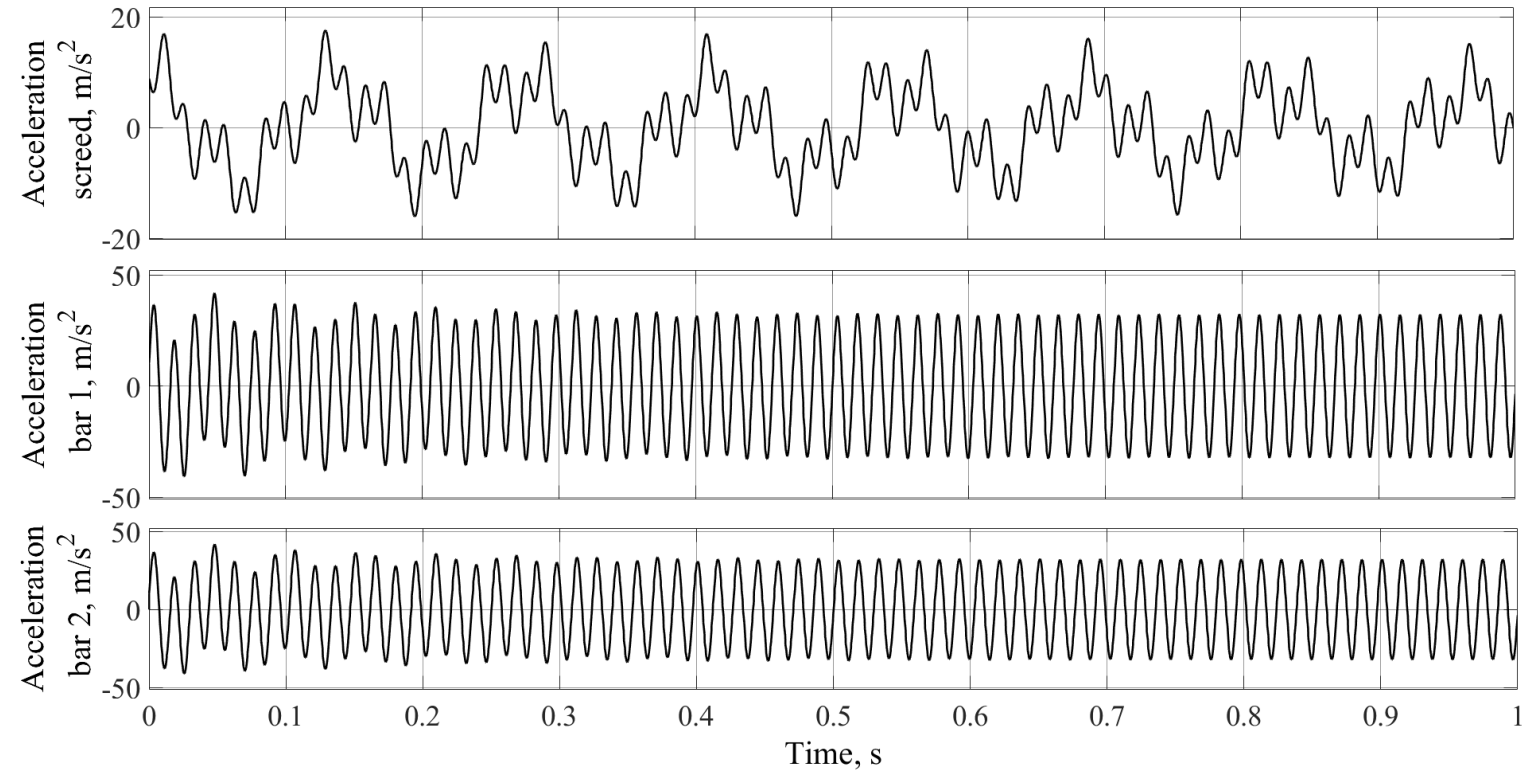
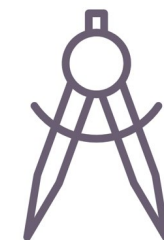


Figure. Graphical dependencies of the oscillating process parameters of the finishing plate and pressure bars of the paver.



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Conclusions

Results, implementation

- Based on the method of variable states, a mathematical model an object of cyber-physical quality control system for asphalt concrete mixtures compaction is obtained. The obtained model was verified by simulation in the MATLAB/Simulink environment.
- The results of the work are a stage of scientific research in the field of designing intelligent control and control systems for cyber physical road construction systems.



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