TECHNICAL UNIVERSITY OF CLUJ-NAPOCA

ACTA TECHNICA NAPOCENSIS

Series: Applied Mathematics, Mechanics, and Engineering
Vol. 69, Issue II, June, 2026

ANALYSIS OF MECHANICAL STRESSES AND OPTIMIZATION OF MOUNTING PARAMETERS FOR OVERHEAD POWER LINES IN URBAN ENVIRONMENTS: CASE STUDY OF THE JIU VALLEY MUNICIPALITIES

Teodora LAZAR, Daria IONESCU, Dan Cristian LAZAR, Adina Milena TATAR, Nicolae Daniel FITA, Dragos PASCULESCU

Abstract: *This paper presents a detailed mechanical analysis of the Al-Ol 50/8 (ACSR) conductor, applied to the overhead power line infrastructure in Hunedoara County, with an emphasis on the specific climatic conditions of the Jiu Valley region. The study investigates the behavior of the conductor under extreme meteorological phenomena, such as severe frost at -30°C and heatwaves reaching +40°C, utilizing the equation of state to determine the critical stress regimes. To substantiate the analytical findings, a three-dimensional numerical simulation was performed using Finite Element Analysis (FEA) in MATLAB, allowing for the identification of local stress concentrations at the conductor's clamping points. By calculating the specific stresses and sags for an average span of 40 meters, it was demonstrated that the minimum temperature regime constitutes the primary stress factor for mechanical integrity, while the maximum sag, critical for safety clearances, is reached during summer heatwaves. The paper concludes with the development of mounting curves and a validation of the structural vulnerability of supporting hardware, providing a practical tool for field teams to ensure the resilience and operational safety of the energy infrastructure under mountain microclimate conditions.*

Key words: *Mechanical Design of OHL, Conductor Equation of State, Finite Element Analysis (FEA), Von Mises Stress, Stringing Curves, Thermal Contraction, Critical span (lcr), Sag and Tension Calculation*

1. INTRODUCTION

1.1 Justification for the mechanical calculation

Unlike underground cables (UGC), which benefit from inherent structural protection and an installation method that eliminates the influence of environmental factors, Overhead Power Lines (OHL) constitute complex technical systems directly exposed to atmospheric dynamics. While electrical sizing ensures the transport capacity of the power flow, the structural stability of the network is guaranteed exclusively by the rigor of the mechanical calculation [1].

The necessity of this calculation derives from the fact that an overhead conductor is not merely a conductive medium, but also a structural element subjected to variable and often extreme mechanical stresses. Electrodynamic forces, although present, become negligible in relation to the external loads imposed by the material's own weight, heavy ice accretions, the pressure exerted by moving air masses, and temperature variations. Consequently, the integrity of the network is conditioned by compliance with minimum cross-sections and allowable specific stresses, parameters regulated by strict operational safety standards.

1.2 Climatic characteristics and risk factors in the Jiu Valley

The analysis of the mechanical behavior of conductors requires precise grounding in the geographical reality of the location. The Jiu Valley, through its configuration as a closed intermountain depression, imposes an entirely particular stress regime for the urban energy infrastructure in municipalities such as Petroșani, Vulcan, or Lupeni.

Received: 06.04.26; **Similarities**: 12.05.26: **Reviewed**:24.05. /125.05.26: **Accepted** 09.06.26.

A determining risk factor is the thermal amplitude; the calculation is designed to cover extremes ranging from a freezing threshold of -30°C to summer temperatures that can reach +40°C. These variations generate cycles of contraction and expansion that constantly modify the internal stress state of the conductor [2]. Furthermore, the rime ice accretion phenomenon represents the main challenge in this mountainous region; although a reference layer of 1.3 cm is standardly used for urban areas located below an altitude of 1000 m, the local microclimate can favor asymmetrical accretions that overload the supporting structure [3].

In this context, evaluating the safety of Overhead Power Lines (OHL) in the urban environment of the Jiu Valley is not merely a simple technical design requirement, but represents an imperative condition for ensuring the continuity of the distribution service. Given the demographic density and the specific urban configuration of this basin, any mechanical failure triggered by extreme meteorological phenomena can generate major socio-economic implications, directly affecting the stability of the vital infrastructure in the municipalities of the region [4].

2. METHODOLOGY FOR CALCULATING SPECIFIC LOADS

In order to compare the effect of uniformly distributed external forces acting on the conductors, their magnitude is related to the cross-sectional area and the length of the conductors, resulting in specific loads expressed in daN/(mm²·m).

2.1 Determination of vertical loads

Vertical loads are generated by the dead weight of the conductor material and by the rime ice accretions specific to the mountainous area of the Jiu Valley.

- **Specific load due to own weight (g_1):** This load is determined by taking into account the specific weight of the material and the structure of the conductor.

$$g_1 = (1{,}02\text{-}1{,}03) \cdot \gamma \; [daN/m \cdot mm^2] \qquad (1)$$

The (1.02 - 1.03) factor compensates for the fact that, in stranded conductors, the length of an individual component wire is (2 - 3) % greater than that of the finished conductor; γ represents the specific weight of the material from which the conductor is manufactured.

- **Specific load due to rime ice (g_2):** Rime ice can deposit in the form of a circular annulus with a thickness of b [mm].

$$g_2 = \frac{\eta \cdot \pi \cdot b(d+b)}{S} \cdot \gamma_{ch} \cdot 10^3 \; [daN/m \cdot mm^2] \qquad (2)$$

where:

- η is a coefficient with a value of 1 for $b \leq 20$ mm (which is the case for the cities in the Jiu Valley, where $b = 13$ mm), and 0.85 for $b > 20$ mm;
- b represents the thickness of the rime ice layer [mm];
- S is the cross-sectional area of the conductor;
- γ_{ch} is the specific weight of the rime ice.

- **Resultant vertical specific load (g_3):** This is obtained by combining the two previous vertical loads.

$$g_3 = g_1 + g_2 \qquad (3)$$

2.2 Calculation of horizontal loads (wind pressure)

Wind pressure acts horizontally, perpendicular to the longitudinal section of the conductors.

- **Specific load due to wind on the clean conductor (g_4):** It is calculated according to the principles of aerodynamics:

$$g_4 = \frac{a \cdot k \cdot d \cdot v^2}{16 \cdot S} \cdot 10^{-3} [daN/m \cdot mm^2] \qquad (4)$$

where:

- a represents the non-uniformity coefficient of the wind speed along the span;
- k represents the aerodynamic drag coefficient of the conductor;
- d represents the outer diameter of the conductor [mm];
- v represents the wind velocity [m/s];

- S represents the cross-sectional area of the conductor [mm^2].
- **Specific load due to wind on the ice-coated conductor (g_6):** It reflects the wind pressure acting on the conductor covered by the ice layer. This is calculated analogously, but the width of the projected lateral area is increased by twice the thickness of the rime ice.

$$g_6 = \frac{0{,}0638 \cdot v^2}{S \cdot 10^3} \cdot (d + 2 \cdot b) \quad (5)$$

where:

- v wind velocity, a critical parameter for the Jiu Valley, where the airflow is channeled along the depression.
- *0,0638* represents the aerodynamic coefficient that integrates the dynamic wind pressure;
- $(d + 2 \cdot b)$ represents the total diameter exposed to the wind (the conductor diameter plus twice the thickness of the rime ice layer).

2.3 Composition of resultant specific loads

The total stress in the conductor depends on the vector resultant of the vertical and horizontal loads.

- **Resultant load from weight and wind (g_5):**

$$g_5 = \sqrt{g_1^2 + g_4^2} \quad (6)$$

- **Total resultant specific load (g_7):**

Represents the numerical value of the load under the most severe loading condition, combining the weight of the ice-coated conductor and the wind pressure acting upon it.

$$g_7 = \sqrt{g_3^2 + g_6^2} \quad (7)$$

The graphical representation below (Figure 1) summarizes the transition from scalar to resultant loads, highlighting the difference between the standard loading (clean conductor) and the most severe design assumption, in which ice accretions maximize both the vertical mass and the wind exposure area.

For a rigorous analysis of the mechanical behavior, the vector representation of the specific loads becomes an indispensable tool, allowing for the visualization of the interaction between gravitational and aerodynamic forces.

Thus, the vertical axis illustrates the accumulation of loads acting in the gravitational direction, respectively the conductor's own weight (g_1) and the weight of the rime ice layer (g_2), whose sum determines the total vertical force (g_3).

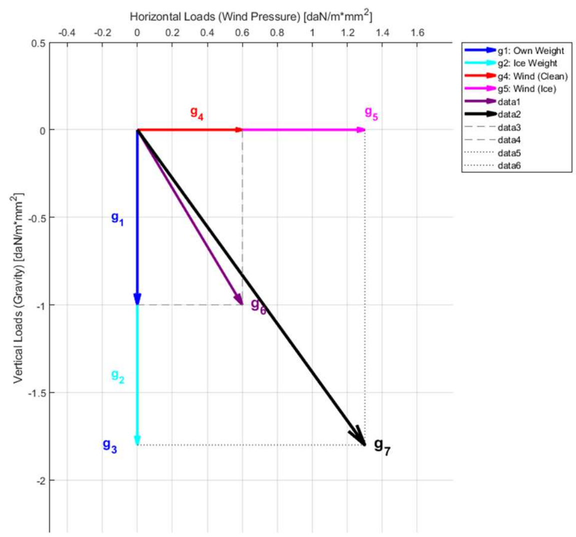

Fig. 1. Vector diagram of the composition of vertical and horizontal specific loads

Simultaneously, the horizontal axis describes the pressure exerted by the wind, highlighting both the load on the clean conductor (g_4) and its significant increase in the case of the ice-coated conductor (g_5), due to the expansion of the exposure area.

The synthesis of these components is materialized by the resultant vectors: g_6, which identifies the composite stress for the normal operating state (own weight and wind), and g_7, which defines the maximum stress under the most severe assumption of rime ice loading under wind pressure.

This latter value, g_7, constitutes the fundamental calculation basis for sizing the supporting elements and verifying the allowable specific stress under the severe climatic conditions in the Jiu Valley.

3. THE EQUATION OF STATE AND MATHEMATICAL MODELING

The mechanical behavior of an overhead conductor under the influence of the variable climatic factors in the Jiu Valley is defined by the fundamental relationship between its physical and geometric parameters, a modeling that allows the anticipation of stress and sag variations to ensure the operation of the line within safety limits.

Although, under the assumption of a perfectly flexible and inextensible wire, the conductor adopts the shape of a catenary curve, in urban power network engineering the parabolic approximation is used for normal spans, where the sag and length can be calculated by neglecting the higher-order terms of the series expansions [5].

This simplification is admitted in light of the fact that the specific stress (σ) can be considered constant at any point of the span, facilitating the use of the sag formula:

$$f = \frac{l^2 \cdot g}{8\sigma} \quad (8)$$

and the conductor length:

$$L = l + \frac{l^3 \cdot g^2}{24\sigma^2} \quad (9)$$

The transition of the conductor from one equilibrium state to another under the influence of thermal variations and loading conditions is mathematically described by the equation of state, which establishes the connection between the quantities g, σ, and θ corresponding to any two stress states [6].

This theoretical formulation, represented by the relationship:

$$\sigma_n - \frac{l^2 \cdot g_n^2}{24\beta\sigma_n^2} = \sigma_m - \frac{l^2 \cdot g_m^2}{24\beta\sigma_m^2} - \frac{\alpha}{\beta} \cdot (\theta_n - \theta_m) \quad (10)$$

allows for the determination of the specific stress in an unknown state, starting from a reference state.

where:

- σ_n, σ_m - specific stresses in the conductor for states n and m [daN/mm²];
- g_n, g_m - the specific loads corresponding to the two states (e.g., with or without rime ice);
- θ_n, θ_m - the temperatures of the conductor in the two calculation hypotheses (covering the range of -30 °C ... +40 °C)
- E - the modulus of elasticity of the material (constant parameter for Al-Ol)
- α - the coefficient of linear thermal expansion of the conductor.

In the urban context, this equation is vital for calculating the stress at which the conductor must be installed at a given temperature, so that under the most disadvantageous hypothesis - whether it is the maximum contraction at the minimum temperature of -30 °C or the maximum rime ice load at -5 °C - the specific stress does not exceed the permissible value for the respective material.

4. CASE STUDY: URBAN NETWORKS IN THE JIU VALLEY (HUNEDOARA)

4.1 Working hypotheses and parameters of the Al-Ol 50/8 conductor

To assess the safety of the networks in the municipalities of Petroșani, Vulcan, or Lupeni, the case study focuses on the analysis of an Al-Ol 50/8 stranded conductor [7], [8].

In this context, we use the critical climatic values previously established for the Jiu Valley region, applied to a typical urban geometry:

- We adopt an average span of l = 40 meters, representative of the distances between poles on the main street network.
- The analysis uses the thermal thresholds of -30 °C (minimum) and +40 °C (maximum), along with a rime ice load of b = 1.3 cm (specific to altitudes below 1000 m).
- These parameters serve as input data for determining the critical regimes that condition both the breaking stress and the safety clearance to the ground

4.2 Practical analysis of critical regimes

4.2.1. Critical span (l_{cr})

The identification of the maximum stress state is achieved through the mathematical determination of the critical span (l_{cr}). This represents the theoretical span length for which the specific stress in the conductor reaches the maximum permissible value (σ_{adm}) under two different hypotheses: at the minimum temperature (-30 °C) and under maximum rime ice conditions (-5 °C).

To determine this equilibrium point, the following relationship is used:

$$l_{cr} = \sigma_a \sqrt{\frac{24 \cdot \alpha \cdot (-5 - \theta_{\min})}{g_7^2 - g_1^2}} \tag{11}$$

where:

σ_{adm} represents the permissible stress, g_7 is the maximum resultant load (rime ice and wind), and g_1 is the self-weight of the conductor.

The correlation between specific stresses and span length is highlighted in Figure 2, which illustrates the variation of stress at the minimum temperature ($\sigma_{\theta\min}$) in relation to the stress generated by the maximum rime ice and wind load ($\sigma_{g\max}$).

It can be observed that for span values $l < l_{cr}$, the thermal contraction stress curve is situated above the loading curve, confirming that in urban areas with short spans, extreme frost represents the critical loading regime.

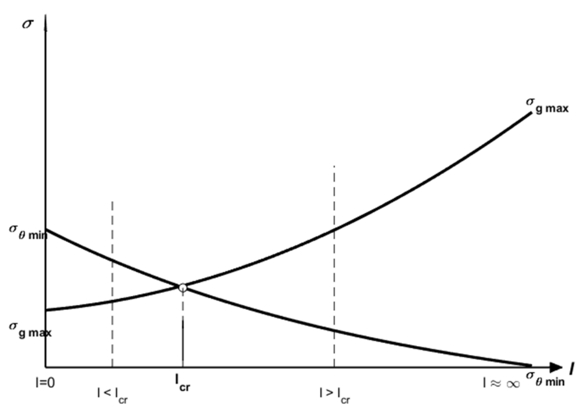

Fig. 2. Variation of the specific stress in the conductor at minimum temperature and under maximum load

The intersection point, marked on the graph at the value l_{cr}, defines the limit at which the weight of ice deposits begins to exert a mechanical pressure greater than the thermal one, becoming the determining factor in the sizing of the line.

To validate the critical loading regime, we use the specific parameters of the Al-Ol 50/8 conductor and the Zone IV rime ice conditions. The input data are:

- g_1 = 0,0033 [daN/m·mm²] (self-weight);
- g_3 = 0,0178 [daN/m·mm²] (weight with rime ice);
- σ_a= 7,5 [daN/mm²] (permissible stress);
- $\Delta\theta$ = (-5) - (-30) = 25 °C (temperature difference).

Applying calculation formula (11), we obtain: $l_{cr} \approx 45{,}2$ m.

By inserting the specific values of the Al-Ol 50/8 conductor and the climatic conditions of the Jiu Valley into the above formula, we obtain a critical span $l_{cr} \approx 45$ m. Comparing this value with the actual 40 m span used in our urban project ($l < l_{cr}$), it mathematically follows that the maximum stress in the conductor is reached at the minimum temperature of -30 °C.

This analysis demonstrates that, in the configuration of urban networks within the inhabited areas of the Jiu Valley, the main risk is not represented by failure under the physical weight of the ice, but by failure due to excessive thermal contraction during periods of frost. Thus, verification at the minimum temperature becomes the priority safety criterion in design.

4.2.2. Determination of the maximum sag regime by calculating the critical temperature (θ_{cr})

To guarantee the safety clearance in urban areas, our objective is to identify the maximum sag value ($f_{\max}$). This can occur either in winter (under the weight of rime ice) or in summer (due to thermal expansion) [9]. To decide which of the two situations is the most unfavorable, we use the critical temperature (θ_{cr}), as a diagnostic tool, according to the relationship:

$$\theta_{cr} = \sigma_3 \cdot \frac{\beta}{\alpha} \cdot (1 - \frac{g_1}{g_3}) \cdot (-5) \tag{12}$$

The analysis of the conditions determining the maximum proximity of the conductor to the ground is summarized in Figure 3, which compares the evolution of the sag under self-weight at high temperatures (f_{g1}) with the sag caused by rime ice deposits at -5 °C (f_{g3}).

The intersection of these curves defines the critical temperature (T_{cr}), an essential parameter for establishing the calculation regime for pole height. It is observed that in the region where $T > T_{cr}$, summer thermal expansion produces a larger sag than the winter ice loading, requiring a rigorous verification of the safety clearance above the roads in Petroșani or Vulcan to prevent the risk of contact with heavy-duty vehicles during heatwave periods.

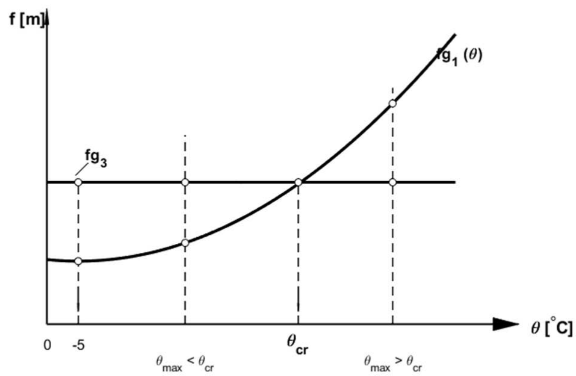

Fig. 3. Variation of the sag as a function of temperature and rime ice

The decision logic of this study is based on the relationship between the maximum design temperature and the theoretically determined critical value. In the specific case of the networks in the Jiu Valley, where the maximum temperature reaches +40 °C, if this threshold exceeds the critical temperature ($T_{max} > T_{cr}$), the thermal expansion of the conductor becomes the determining factor, generating a sag greater than that produced by the rime ice weight during winter. Conversely, if $T_{max} < T_{cr}$, the maximum requirement for clearance would have remained within the rime ice regime.

The graphical representation in Figure 3 highlights exactly this intersection point (T_{cr}), where the vertical axis indicates the sag values (f) for both hypotheses. From a practical perspective, for the Al-Ol 50/8 conductor, the calculation confirms that during the heatwave periods of July and August, the electrical network in cities such as Vulcan or Petroșani reaches its maximum sag, marking the critical moment when the overhead clearance above roads is most restricted.

5. PRACTICAL IMPLEMENTATION: INSTALLATION CURVES

5.1. Plotting and interpreting the installation charts

The practical outcome of the mechanical study for the Al-Ol 50/8 conductor consists of developing the stringing curves, which are essential tools that translate theoretical calculations into field instructions for the networks in the Jiu Valley. The process of plotting these charts involves determining the stress and sag at which the conductor must be tensioned during installation, using the actual ambient temperature as the primary variable. Given that climatic conditions in areas such as Petroșani or Vulcan are fluctuating, the stringing curves are calculated for an average span of 40 meters, thereby providing a consistent reference base for the entire analyzed street layout [10].

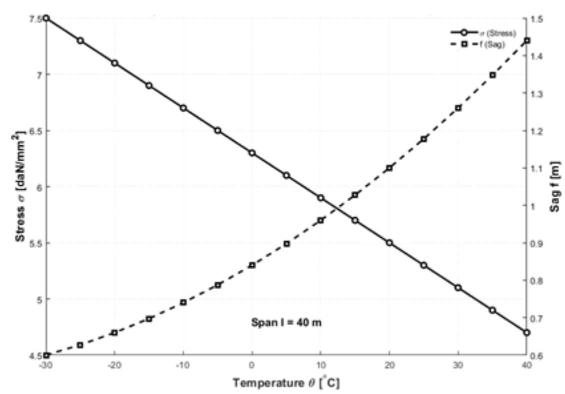

Fig. 4. Stringing curves for the Al-Ol 50/8 conductor at span l = 40 m

The visual representation of these parameters highlights an inverse correlation between stress and temperature: as the ambient temperature rises, the tensile stress (σ) is reduced to allow for the thermal expansion of the metal, while the sag value (f) increases accordingly [11]. This fine-tuning, performed during the stringing phase, ensures that at extreme frost temperatures of -30 °C, the conductor's contraction will not generate mechanical forces that exceed the breaking strength of the material or the supporting elements.

5.2. Numerical validation of stress Distribution through finite element analysis (FEA)

To substantiate the analytical calculation hypotheses and evaluate the real structural behavior of the Al-Ol 50/8 bimetallic conductor at the attachment points, a three-dimensional simulation was performed using the Finite Element Method (FEA) in the MATLAB environment (PDE Toolbox).

Although the analytical model based on the equation of state assumes a constant specific stress along the span of the line, in reality, the mechanical interaction at the level of the suspension and tension clamps generates a complex regime of local stresses [12].

The mathematical model implemented for the numerical solution is based on the static equilibrium equations of three-dimensional linear elasticity [13]. From a tensorial perspective, the behavior of the structure under the action of external loads is governed by the Cauchy equilibrium equation:

$$\nabla \cdot \sigma + F = 0 \tag{13}$$

where σ represents the stress tensor, and F is the body force vector.

The relationship between stresses and strains (the strain tensor $\mathcal{E}$) in the elastic regime for an isotropic material is described by the generalized Hooke's law:

$$\sigma = C / \varepsilon \tag{14}$$

where C is the stiffness tensor, dependent on the material properties: Young's modulus (E) and Poisson's ratio (v).

As the analysis targets a complex state of spatial stress (combined tension, shear, and bending), the evaluation of the stress state was performed using the distortion energy criterion (Von Mises) [14]. The Von Mises equivalent stress (σ_{vM}) is calculated based on the components of the stress tensor through the following relationship:

$$\sigma_v = \sqrt{\frac{1}{2}\left[\left(\sigma_x-\sigma_y\right)^2+\left(\sigma_y-\sigma_z\right)^2+\left(\sigma_z-\sigma_x\right)^2+6\left(\tau_{xy}^2+\tau_{yz}^2+\tau_{zx}^2\right)\right]} \tag{15}$$

This mathematical model was discretized using a tetrahedral finite element mesh applied to a bimetallic cylindrical geometry [15]. Distinct elastic properties were assigned to the steel core (E = 200 GPa, v = 0.3) and the aluminum sheath (E = 69 GPa, v = 0.33).

As boundary loads, the axial tensile stress resulting from the equation of state was applied to the free end of the segment, superimposed with the transverse force generated by the critical loading scenario (the maximum resultant specific load g_7 due to wind and rime ice action).

The base of the segment was fully kinematically constrained (fixed support condition), simulating the stiffness of the suspension clamp.

The result of the analysis regarding the equivalent stress distribution is presented in Figure 5. It is observed that on the free portion of the span, the stress remains uniform (highlighted by the cool/blue hues), validating the global analytical calculation for the body of the line.

However, at the clamping interface, the shear effect generates a significant stress concentration [16].

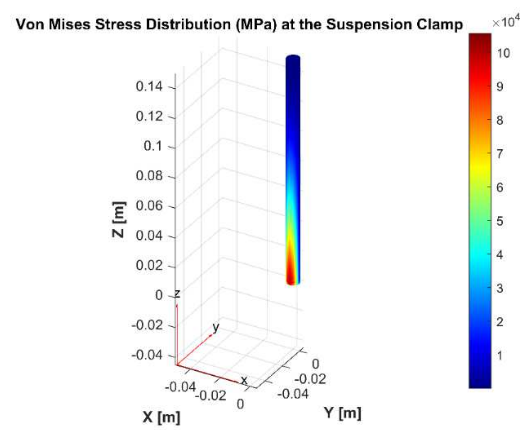

Fig. 5. Von Mises stress distribution at the clamping point for the Al-Ol 50/8 bimetallic conductor

Complementary to the stress state analysis, the resultant displacement field was also evaluated, as illustrated in Figure 6. This representation highlights the spatial deformation mode of the bimetallic segment under the effect of combined transverse loads.

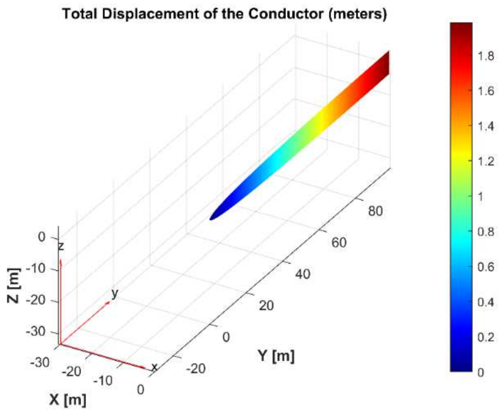

Fig. 6. Total displacement field and structural deformation of the conductor segment.

The pronounced bending of the conductor at the exit from the fixed support (Figure 6) mechanically justifies the previously observed stress concentration: the kinematic constraint imposed by the clamp opposes the natural tendency of the cable to assume a curved profile under the aerodynamic wind pressure and the weight of the ice mass.

This numerical validation demonstrates that the mechanical design of overhead power lines in the severe climatic conditions of the Jiu Valley should not be limited solely to verifying the average span stress [17]. Operational safety depends critically on the strength of the supporting hardware and the conductors in the vicinity of the clamps—vulnerable points where the interaction between thermal contraction and extreme transverse loads leads to a maximization of internal stress.

6. CONCLUSIONS

The mechanical study of the Al-Ol 50/8 conductor demonstrates the fundamental importance of tailoring electrical network design to the specific microclimate of Hunedoara County. The analysis highlighted that the infrastructure in the urban areas of the Jiu Valley such as Petroșani, Vulcan, or Lupeni is subject to extreme dual stresses: severe thermal contractions at temperatures of -30 °C and pronounced conductor expansion during heatwaves of up to +40 °C.

The main conclusion of this work indicates that urban infrastructure safety depends not only on material strength but also on the correct identification of the critical regime. For short spans of approximately 40 meters, typical of street environments, it was demonstrated that the contraction stress during extreme frost represents the most dangerous load for the integrity of the attachment points. In parallel, the calculation of the critical temperature (T_{cr}) confirmed that the maximum sag—essential for maintaining safety clearance above high-traffic roads—occurs on scorching summer days, necessitating a rigorous design of pole heights.

Complementing the analytical analysis, three-dimensional finite element modeling (FEA) validated the theoretical calculation hypotheses and brought to the forefront a critical mechanical phenomenon: the emergence of stress concentrations at the conductor's clamping interface. The numerical analysis of the stress field (Von Mises) and total displacements visually and mathematically demonstrated that the kinematic constraint imposed by the supporting hardware opposes the cable's natural tendency to bend under transverse forces (wind and rime ice). Therefore, the design and maintenance of urban networks in the Jiu Valley must prioritize verifying the mechanical integrity of the supporting fittings, as they represent the most vulnerable links in the infrastructure under the combined effect of maximum tension and aerodynamic loads.

As practical recommendations, it is imperative that field teams exclusively use the stringing curves calculated for the actual average span of the section, ensuring a precise correlation between ambient temperature and tensile stress.

Any deviation from these charts, especially over-tensioning the conductor, eliminates the system's elasticity reserve and exponentially increases the risk of failure during blizzards or severe frost. Implementing these technical solutions is the only way to ensure the resilience of distribution networks and the safety of citizens in the face of extreme weather phenomena in the mountain region of Hunedoara.

7. REFERENCES

[1] Utu, I., Pasculescu, D., *Power quality study in order to comply with European Norms,* Calitatea 18.S1, 2017.

[2] Ngoko, B., Sugihara, H., Funaki, T., *A Temperature Dependent Power Flow Model Considering Overhead Transmission Line Conductor Thermal Inertia Characteristics,* 2019 IEEE International Conference on Environment and Electrical Engineering and 2019 IEEE Industrial and Commercial Power Systems Europe (EEEIC / I&CPS Europe), Genova, Italy, 2019.

[3] Li, J., Liu, W., Zhang, H., Liu, X., *Ampacity Calculation Method for Overhead Conductors in High-Altitude Areas Based on Numerical Simulation*, Energies, 19, 392, 2026.

[4] Kulikov, A., Ilyushin, P., Loskutov, A., Filippov, S., *Fault Location Method for Overhead Power Line Based on a Multi-Hypothetical Sequential Analysis Using the Armitage Algorithm*, Inventions, 8, 123, 2023.

[5] Kampik, M., Kubek, P., Krupanek, B., Bogacz, R., *Sag and Tension Calculations for High-Voltage Overhead Line Conductors*, Energies, 17, 2967, 2024.

[6] Jun, L., Hezhi, L., Dingyou, J., Yunyun, X., Xu, W., Ying, J., *The comparison of conductor stress calculation methods for overhead line under extreme weather conditions,* IEEE PES Asia-Pacific Power and Energy Engineering Conference (APPEEC), Hong Kong, China, 2013.

[7] Pu, Y., Sun, J., Xiao, Q., Zhou B., Liao, S., *A Pulsed Electromagnetic Eddy Current Method for Detecting Broken Strands of ACSR Conductor in Steel/AL Materials,* First International Conference on Cyber-Energy Systems and Intelligent Energy (ICCSIE), Shenyang, China, 2023.

[8] Jalilian, M., Riba, J.-R., Parvizi, P., *Aluminum Conductor Steel-Supported Conductors for the Sustainable Growth of Power Line Capacity: A Review and Discussion*, Materials, 17, 4536, 2024.

[9] Neagu, B. C., Zetu, C., Grigoras, G., Ivanov, O., *Theories about Mechanical Calculus in the Context of Coexistence between Overhead Power Lines and Buildings from Outskirts of Cities,* International Conference on Electromechanical and Energy Systems (SIELMEN), Iasi, Romania, 2021.

[10] Pasculescu, D., Riurean, S., Ilieva-Obretenova, M., Lazar, T., Tatar, A.M., Fita, N.D., *Intelligent Modeling of PV–BESS Microgrids for Enhanced Stability, Cyber–Physical Resilience and Blackout Prevention*, Energies, 19, 148, 2026.

[11] Fusiek, G., Niewczas, P., *Force and Temperature Characterization of a Novel Fiber Bragg Grating Overhead Line Sensor*, Sensors, 25, 7425, 2025.

[12] Andras, A., Brînaș, I., Radu, S.M., Popescu, F.D., Popescu, V., Budilică, D.I. *Investigation of the Thermal Behaviour for the Disc-Pad Assembly of a Mine Hoist Brake Using COMSOL Multiphysics*, Acta Technica Napocensis - Series: Applied Mathematics, Mechanics, And Engineering, 64, 227–234, 2021.

[13] Andras, A., Popescu, F.D., Radu, S.M., Pasculescu, D., Brinas, I., Radu, M.A., Peagu, D. *Numerical Simulation and Modeling of Mechano–Electro–Thermal Behavior of Electrical Contact Using COMSOL Multiphysics*, Appl. Sci., 14, 4026, 2024.

[14] Boldeiu, G., Vasilache, D., Moagar, V., Stefanescu, A., Ciuprina, G., *Study of the von Mises stress in RF MEMS switch anchors*, International Semiconductor Conference (CAS), Sinaia, Romania, 2015

[15] Yu, J., Wu, C., Huang, H., Xie, D., Qin, F., Jiang, J., He, G., *Discussion on AC Resistance and Temperature of ACSR Based on Finite Element Model Assistance*, Energies, 18, 539, 2025.

[16] Lazar, D.C., Petrilean, D.C., Lazar, T., Popescu, F.G., Ionescu, D., Tatar, A.M., Buica, G., Pasculescu, D., *Real-Time Energy System Optimization and Resilience Analysis in Low-Voltage Networks Using Intelligent Edge Computing*, Processes, 14, 660, 2026.

[17] Bendík, J., Cenký, M., Eleschová, Ž., Beláň, A., Cintula, B., Janiga, P., *Influence of Tension Insulators and Bundle Conductors on Sag of Conductors in Substations*, 22nd

International Scientific Conference on Electric Power Engineering (EPE), Kouty nad Desnou, Czech Republic, 2022

Analiza eforturilor mecanice şi optimizarea parametrilor de montaj pentru liniile electrice aeriene în mediul urban: Studiu de caz al municipiilor din Valea Jiului

Rezumat: Această lucrare prezintă o analiză mecanică detaliată a conductorului Al-Ol 50/8 (ACSR), aplicată infrastructurii de linii electrice aeriene din județul Hunedoara, cu accent pe condițiile climatice specifice regiunii Văii Jiului. Studiul investighează comportamentul conductorului sub acțiunea fenomenelor meteorologice extreme, precum gerul sever de -30°C și perioadele de caniculă de până la +40°C, utilizând ecuația de stare pentru a determina regimurile critice de solicitare. Pentru a fundamenta rezultatele analitice, s-a realizat o simulare numerică tridimensională utilizând Analiza cu Elemente Finite (FEA) în mediul MATLAB, care a permis identificarea concentratorilor locali de tensiune la nivelul punctelor de prindere ale conductorului. Prin calculul eforturilor specifice și al săgeților pentru o deschidere medie de 40 de metri, s-a demonstrat că regimul temperaturii minime constituie principalul factor de solicitare pentru integritatea mecanică, în timp ce săgeata maximă, critică pentru respectarea gabaritului de siguranță deasupra căilor de rulare, este atinsă în timpul valurilor de căldură estivale. Lucrarea se concluzionează cu elaborarea curbelor de montaj și validarea vulnerabilității structurale a armăturilor de susținere, oferind un instrument practic pentru echipele de teren, menit să asigure reziliența și siguranța în exploatare a infrastructurii energetice în condițiile unui microclimat montan.

Teodora LAZAR, Lecturer PhD Eng., University of Petrosani, Automation, Computer, Electrical and Power Department, 20 University Street, 332006, Petroşani, Romania, E-mail: teodoralazar@upet.ro, Phone: 00 40 720774403, Petroşani, Romania;

Daria IONESCU, Master Student, University of Petrosani, Industrial Engineering and Management Department, 20 University Street, 332006, Petroşani, Romania, E-mail: daria.ionescu20@yahoo.com, Phone: 00 40 725479297, Petroşani, Romania;

Dan Cristian LAZAR, PhD. Student, University of Petrosani, Automation, Computer, Electrical and Power Department, 20 University Street, 332006, Petroşani, Romania, E-mail: dan-cristianlazar@upet.ro, Phone: 00 40 770613614, Petroşani, Romania;

Adina Milena TATAR, Associate Professor PhD Eng., University "Constantin Brancusi" of Targu-Jiu, Department of Industrial and Automation Engineering, 210135 Targu-Jiu, Romania; adynatatar@gmail.com, Phone: 00 40 723285492, Targu-Jiu, Romania;

Nicolae Daniel FITA, Lecturer PhD Eng., University of Petrosani, Automation, Computer, Electrical and Power Department, 20 University Street, 332006, Petroşani, Romania, E-mail: daniel.fita@yahoo.com, Phone: 00 40 731063310, Petroşani, Romania;

Dragos PASCULESCU, Associate Professor PhD Eng., University of Petrosani, Automation, Computer, Electrical and Power Department, 20 University Street, 332006, Petroşani, Romania, E-mail: dragospasculescu@upet.ro, Phone: 00 40 721705284, Petroşani, Romania;