

Projekt badawczy Narodowego Centrum Nauki pt.:

Optymalizacja topologiczna konstrukcji inżynierskich. Ujęcie syntetyzujące metody: projektowania anizotropii z wolnego wyboru, projektowania materiałów niejednorodnych oraz metodę siatek typu Michella,

Kierownik: prof. dr hab. inż. Tomasz Lewiński,

Politechnika Warszawska; Wydział Inżynierii Lądowej,

środki przyznane: 772 040 zł,

zajął 5. miejsce spośród 188 projektów złożonych w ramach konkursu: OPUS, Panel ST 8 (data ogłoszenia: 16 IX 2013 r.). Do drugiego etapu zakwalifikowano 47 wniosków; do finansowania skierowano 32 wnioski.

Projekt ten będzie wykonywany w ramach umowy:

UMO-2013/11/B/ST8/04436

zawartej w dniu 15 lipca 2014 r. pomiędzy

NCN a Politechniką Warszawską.

Nr projektu: 2013/11/B/ST8/04436

Okres realizacji: 15.07.2014-14.07. 2017, przedłużony aneksem do 14.12.2017.

Publikacje (2014-2017)

1 Książka w opracowaniu

T. Lewiński , T. Sokół, C. Graczykowski, *Michell Structures* 2018; ok 450 str.

2 Publikacje w periodykach

K.Bołbotowski, S.Czarnecki, R.Czubacki, G.Dzierżanowski, T.Lewiński, T.Łukasiak,T.Sokół, *Zagadnienia kształtowania konstrukcji w ujęciu współczesnej mechaniki, Inżynieria i Budownictwo*, No 8/ 2017 str. 437-441

N. Briggs, A. Cherkaev, G. Dzierżanowski, 2015, A note on optimal design of multiphase elastic structures, *Structural and Multidisciplinary Optimization* 51(3): 749-755.

Czarnecki, S. 2015. Isotropic Material Design. *Computational Methods in Science and Technology* 21(2): 49–64.

S. Czarnecki, T.Lewiński, On material design by the optimal choice of Young's modulus

distribution, *International Journal of Solids and Structures* vol. 110–111 (2017) 315–331 <http://dx.doi.org/10.1016/j.ijsolstr.2016.11.021>

S.Czarnecki, T.Lewiński, Pareto optimal design of nonhomogeneous isotropic material properties for the multiple loading conditions, *Physica Status Solidi B: Basic Solids State*

Physics. 2017 vol. 254, 1600821, 1-14, (DOI:10.1002/pssb.201600821) <https://doi.org/10.1002/pssb.201600821>

S. Czarnecki, T.Lewiński, P.Wawruch, On shape and material optimization of isotropic bodies, Engineering Transactions.2017, 65, no 1, 3–9.

Czarnecki S., Łukasiak T., Lewiński T., The Isotropic and Cubic Material Designs. Recovery of the underlying Microstructures Appearing in the Least Compliant Continuum Bodies

Materials 2017, 10(10), 1137; doi:10.3390/ma10101137
<http://www.mdpi.com/1996-1944/10/10/1137>

Czarnecki, S. & Wawruch, P. 2015. The emergence of auxetic material as a result of optimal isotropic design. Physica Status Solidi B 252 (7): 1620–1630.

R. Czubacki, J.F.Ganghoffer, T.Lewiński, Simultaneous design of optimal shape and local cubic material characteristics, Engineering Transactions, 2017, 65, no 1, 11-17

R.Czubacki, T.Lewiński, Topology optimization of spatial continuum structures made of non-homogeneous material of cubic symmetry, Journal of Mechanics of Materials and Structures, 10 (2015), no 4, 519-535, DOI:10.2140/jomms.2015.10.519

G. Dzierżanowski, Application of the Isotropic Material Design and Inverse Homogenization in 3D printing, Engineering Transactions, 64(4), 465–471, 2016

IPPT PAN, IF=0.395
<http://et.ippt.gov.pl/index.php/et/article/view/742>

I.Goda, J.F. Ganghoffer, S. Czarnecki, P.Wawruch, T.Lewiński, Optimal internal architectures of femoral bone based on relaxation by homogenization and isotropic material design, Mechanics Research Communications, 76(2016) str. 64-71.

Elsevier IF=1.4
<http://dx.doi.org/10.1016/j.mechrescom.2016.06.007>

Górny, W., Rybka, P. and Sabra A., Special cases of the planar least gradient problem, Nonlinear Analysis 151 (2017), 66-95,

<http://dx.doi.org/10.1016/j.na.2016.11.020>

link do wydawnictwa, praca opublikowana w schemacie open access:

<http://www.sciencedirect.com/science/article/pii/S0362546X16303005?via%3Dihub>

plik jest tu:

<http://www.mimuw.edu.pl/~rybka/artykuly/gorny-rybka-sabra-1-s2.0-S0362546X16303005-main.pdf>

Łukasiak T., TwoPhase Isotropic Composites of Extremal Moduli. The Inverse Homogenization Problem, Engineering Transactions. 65, 1, 31-38, 2017, ISSN: 0867-888X (Print), 2450-8071 (Online)

<http://et.ippt.gov.pl/index.php/et/article/view/759>

Nakayasu, A., Rybka, P. Integrability of the derivative of solutions to a singular one-dimensional parabolic problem, Plik załączony, praca została złożona w Topol. Method in Nonlinear Anal.

Rybka, P., Sabra, A. The planar Least Gradient problem in convex domains, link do pracy: <https://arxiv.org/pdf/1712.07150.pdf>

Praca została złożona w Indiana University Mathematics Journal

T.Sokół, T.Lewiński, Simply supported Michell trusses generated by a lateral point load. Structural and Multidisciplinary Optimization. 54(2016) no5, pp. 1209-1224

T.Sokół, T.Lewiński, Solution of the three forces problem in a case of two forces being mutually orthogonal, Engineering Transactions 64 (2016), no 4, str. 485–491.

IPPT PAN, IF=0.395

<http://et.ippt.gov.pl/index.php/et/article/view/758>

3 Rozdziały w książkach

G. Dzierżanowski, K. Bołbotowski, 2015, Wybrane zagadnienia optymalizacji konstrukcji, w: A. Garstecki, W. Gilewski, Z. Pozorski (red.) Współczesna mechanika konstrukcji w projektowaniu inżynierskim, Studia z zakresu inżynierii nr 92, Polska Akademia Nauk, Komitet Inżynierii Lądowej i Wodnej, Warszawa, s. 41-56.

Czubacki R., Czarnecki S., Optymalizacja topologiczna materiałów w zakresie sprężystym z założoną klasą anizotropii, Rozdział X w: Monografia. Sprężystość i lepkosprężystość małych odkształceń. Wybrane zagadnienia., red: S.Jemioło OWPW, pp. 159-168, 2017, ISBN: 978-83-7814-703-9

4 Materiały konferencyjne

K. Bołbotowski & T. Sokół: New method of generating Strut and Tie models using truss topology optimization, pp. 97-100, w: M.Kleiber, T. Burczyński, K. Wilde, J. Górski, K. Winkelmann, Ł. Smakosz (Red.), Advances in Mechanics: Theoretical, Computational and Interdisciplinary Issues. Taylor & Francis Group, London, ISBN 978-1-138-02906-4, CRC Press Balkema 2016

S. Czarnecki & P. Wawruch: Construction of stress trajectories in optimal, non-homogeneous elastic bodies, pp. 137-140, w: M.Kleiber, T. Burczyński, K. Wilde, J. Górski, K. Winkelmann, Ł. Smakosz (Red.), Advances in Mechanics: Theoretical, Computational and Interdisciplinary Issues. Taylor & Francis Group, London, ISBN 978-1-138-02906-4, CRC Press Balkema 2016

S. Czarnecki, T. Lewiński, Pareto optimal design of non-homogeneous isotropic materials properties for the multiple loading conditions, 7th International Conference Auxetics and other materials and models with "negative" characteristics 12th International Workshop Auxetics and related systems 12–16 September 2016, Szymbark, Poland – Abstract Book, page 17, Eds. J. W. Narojczyk, J. Rybicki, and K. W. Wojciechowski,

Publisher: Faculty of Applied Physics and Mathematics and TASK Publishing Gdansk University of Technology 80-233 Gdansk, Gabriela Narutowicza 11/12 phone: +48 58 347 13 10; fax: +48 58 347 28 21 Gdansk 2016

ISBN 978–83–937979–9–8

S. Czarnecki, A Stress-based approach in free material design, 20th Inter-Institute Seminar for Young Researchers from Budapest University of Technology and Economics, Cracow University of Technology and Vienna University of Technology. Place of Seminar: Cracow, Department of Civil Engineering, Cracow University of Technology, October 9-10, 2015, Chairman: Dr hab. Jerzy Pamin

S. Czarnecki, R. Czubacki, T. Lewiński, P. Wawruch, Topology optimization of continuum structures made of non-homogeneous materials of isotropic or cubic symmetry, pp 1-6, 11th World Congress on Structural and Multidisciplinary Optimisation 07th -12th, June 2015, Sydney Australia

S. Czarnecki, G. Dzierżanowski, T. Lewiński, P. Wawruch, On recent developments in free material design. Interaction of Applied Mathematics and Mechanics (Conference IAMMC 2017) May 09 to 12, 2017 organized on the occasion of the 60th anniversary of signing an agreement concerning cooperation between Polish Academy of Sciences (PAN) and Centre National de la Recherche Scientifique (CNRS). Scientific Center of the Polish Academy of Sciences in Paris; 74, rue Lauriston – 75116 Paris The Conference website:

<http://iammc2017.ippt.pan.pl/>

. Org.: Centre Scientifique de l'Académie Polonaise des Sciences a Paris; Institute of Fundamental Technological Research, Polish Academy of Sciences.

S. Czarnecki, T. Lewiński, On material design by the Pareto optimal choice of elastic moduli distribution, CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017, Lublin, Poland, eds. Burczyński T., Kuczma M., Warmiński J., Podgórski J., Błazik-Borowa E., Lipecki T., Book of Abstracts MS01-1, ISBN 978-83-7947-264-2

S. Czarnecki, T. Lewiński, T. Łukasiak, P. Wawruch, Design of additively manufacturable least compliant structures CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017, Lublin, Poland, eds. Burczyński T., Kuczma M., Warmiński J., Podgórski J., Błazik-Borowa E., Lipecki T., Book of Abstracts MS01-19. ISBN 978-83-7947-264-2

S. Czarnecki, R. Czubacki, P. Wawruch, Stress based version of isotropic material design in two dimensions, In: M. Kleiber, T. Burczyński, K. Wilde, J. Górski, Ł. Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics,

Short papers, vol.2, pp. 631-632, Gdańsk 2015, copyright by Polish Soc. Theor. Appl.Mech., Gdańsk Branch.

S. Czarnecki, P. Wawruch, Selected problems of numerical analysis of Free Material Design, In: M.Kleiber, T.Burczyński, K.Wilde, J.Górski, Ł.Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics, Short papers, vol.2, pp. 633-634, Gdańsk 2015, copyright by Polish Soc. Theor. Appl.Mech., Gdańsk Branch.

S. Czarnecki, R. Czubacki, T. Lewiński, Topology optimization of spatial continuum structures made of non-homogeneous material of cubic symmetry, In: M.Kleiber, T.Burczyński, K.Wilde, J.Górski, Ł.Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics, Short papers, vol.2, pp. 635-636, Gdańsk 2015, copyright by Polish Soc. Theor. Appl.Mech., Gdańsk Branch.

S.Czarnecki, R.Czubacki, T.Lewiński, P.Wawruch, The Free Material Design reduced to the Monge-Kantorovich problem, In: M.Kleiber, T.Burczyński, K.Wilde, J.Górski, Ł.Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics, Short papers, vol.1, pp. 211-212, Gdańsk 2015, copyright by Polish Soc. Theor. Appl.Mech., Gdańsk Branch.

Czubacki R., Material orientation design of planar structures with prescribed

anisotropy classes. Study of rhombic systems., AIP Conference Proceedings 1922, 020005, 2018, <https://doi.org/10.1063/1.5019032>

R. Czubacki. Material orientation design of planar structures with prescribed anisotropy classes. CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017, Lublin, Poland, eds. Burczyński T., Kuczma M., Warمیński J., Podgórski J., Błazik-Borowa E., Lipecki T., Book of Abstracts MS01-9. ISBN 978-83-7947-264-2

R. Czubacki, J.-F. Ganghoffer, T.Łukasiak, . Comparison Of Free Material Design, Cubic Material Design And Isotropic Material Design Optimization Methods, Interaction of Applied Mathematics and Mechanics (Conference IAMMC 2017) May 09 to 12, 2017 organized on the occasion of the 60th anniversary of signing an agreement concerning cooperation between Polish Academy of Sciences (PAN) and Centre National de la Recherche Scientifique (CNRS). Scientific Center of the Polish Academy of Sciences in Paris; 74, rue Lauriston – 75116 Paris
The Conference website: <http://iammc2017.ippt.pan.pl/> . Org.: Centre Scientifique de l'Académie Polonaise des Sciences a Paris; Institute of Fundamental Technological Research, Polish Academy of Sciences.

I.Goda, J.F.Ganghoffer and T.Lewiński, Evolutionary and topology optimization based algorithms for bone external and internal remodeling., 40th Solid Mechanics Conference,

Warsaw, August 29th –September 2nd 2016. In: Z.Pęcherski, Ed.. Paper available online:

<http://solmech2016.ippt.pan.pl/Abstracts/0041.pdf>

G. Dzierżanowski, Inverse homogenization in isotropic material design, 40th Solid Mechanics Conference, Warsaw, August 29th –September 2nd 2016. In: Z.Pęcherski, Ed.. Paper available online:

<http://solmech2016.ippt.pan.pl/Abstracts/0090.pdf>

Grzegorz Dzierżanowski, Optimal structures made of two elastic materials and void, Continuum Models Discrete Systems (CMDS-13), University of Utah, July 21-25 2014, Salt Lake City, Utah, USA

<http://www.math.utah.edu/~cmds13/Documents/GrzegorzDzierzanowskiPresentation.pdf>

(dostęp 12.01.2016)

Dzierżanowski G., Customizing engineering moduli of elasticity in the context of structural optimization. CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017, Lublin, Poland, eds. Burczyński T., Kuczma M., Warmiński J., Podgórski J., Błazik-Borowa E., Lipecki T., Book of Abstracts MS01-25. ISBN 978-83-7947-264-2.

Dzierżanowski G., Cherkaev A., Optimal three-phase microstructures in plane elasticity. Interaction of Applied Mathematics and Mechanics (Conference IAMMC 2017) May 09 to 12, 2017 organized on the occasion of the 60th anniversary of signing an agreement concerning cooperation between Polish Academy of Sciences (PAN) and Centre National de la Recherche Scientifique (CNRS). Scientific Center of the Polish Academy of Sciences in Paris; 74, rue Lauriston - 75116 Paris The Conference website: <http://iammc2017.ippt.pan.pl/> . Org.: Centre Scientifique de l'Académie Polonaise des Sciences a Paris; Institute of Fundamental Technological Research, Polish Academy of Sciences.

G.Dzierżanowski and T.Lewiński, Young's Modulus Control in Material and Topology Optimization, pp 1374-1385 in: A.Schumacher, Th.Vietor, S.Fiebig, K.U. Bletzinger, K.Maute, Editors. Advances in Structural and Multidisciplinary Optimization. Proceedings of the 12th World Congress of Structural and Multidisciplinary Optimization (WCSMO12). Springer International Publishing AG 2018, Cham, Switzerland.

T.Lewiński, S.Czarnecki, R.Czubacki and T.Sokół, Topology and material optimization of plates and shells, pp. 19-29 in: W.Pietraszkiewicz and W.Witkowski (Eds.) Shell Structures: Theory and Applications. Vol.4. Proc.of the 11th Conference "Shell Structures: Theory and Applications" (SSTA 2017), October 11-13, 2017 . CRC Press. Taylor&Francis Group Boca Raton, London, New York, London 2018.

T.Lewiński, K. Bołbotowski, S. Czarnecki, R. Czubacki, G. Dzierżanowski, T. Łukasiak, T. Sokół and P.Wawruch, Optimization of structural topology, (referat plenarny, wygłoszony przez pierwszego z autorów) 40th Solid Mechanics Conference, Warsaw, August 29th –September

2nd 2016. In: Z.Pęcherski, Ed..

http://solmech2016.ippt.pan.pl/Abstracts/0019_plenary.pdf

Lewiński T, Czarnecki S., Czubacki R., Łukasiak T., Wawruch P., Constrained Versions of the Free Material Design Methods and their applications in 3D printing, in Advances in Structural and Multidisciplinary Optimization, Proceedings of the 12th World Congress of Structural and Multidisciplinary Optimization (WCSMO12) eds. Schumacher A., Vietor T., Fiebig S., Bletzinger KU., Maute K., pp. 1317-1332, 2018 Springer International Publishing AG, doi.org/10.1007/978-3-319-67988-4, ISBN 978-3-319-67987-7, <https://link.springer.com/book/10.1007/978-3-319-67988-4>

Łukasiak T., Multi-parameter underlying micro-structures in the FE inverse homogenization process towards extreme isotropic composites. CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017 Lublin, Poland, eds. Burczyński T., Kuczma M., Warmiński J., Podgórski J., Błazik-Borowa E., Lipecki T., Book of Abstracts MS01-3.

ISBN 978-83-7947-264-2

Łukasiak T. Macroscopically isotropic and cubic-isotropic two-material periodic structures constructed by the inverse homogenization method. in Advances in Structural and Multidisciplinary Optimization, Proceedings of the 12th World Congress of Structural and Multidisciplinary Optimization (WCSMO12) eds. Schumacher A., Vietor T., Fiebig S., Bletzinger KU., Maute K., pp. 1333-1348, 2018 Springer International Publishing AG, doi.org/10.1007/978-3-319-67988-4,

ISBN 978-3-319-67987-7, <https://link.springer.com/book/10.1007/978-3-319-67988-4>

T. Łukasiak. HSrho – an isotropic interpolation scheme based on Hashin-Shtrikman variational bounds, In: M.Kleiber, T.Burczyński, K.Wilde, J.Górski, Ł.Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics, Short papers, vol.2, pp. 647-648, Gdańsk 2015, copyright by Polish Soc. Theor. Appl.Mech., Gdańsk Branch.

T.Łukasiak, Two-phase isotropic composites of extremal moduli. The inverse homogenization problem. 40th Solid Mechanics Conference, Warsaw, August 29th –September 2nd 2016. In: Z.Pęcherski, Ed.. Paper available online:

<http://solmech2016.ippt.pan.pl/Abstracts/0075.pdf>

T. Łukasiak: HSp – an isotropic material interpolation scheme based on Hashin-Shtrikman variational bounds, pp. 355-359, , w: M.Kleiber, T. Burczyński, K. Wilde, J. Górski, K. Winkelmann, Ł. Smakosz (Red.), Advances in Mechanics: Theoretical, Computational and Interdisciplinary Issues. Taylor & Francis Group, London, ISBN 978-1-138-02906-4, CRC Press Balkema 2016

G.I.N.Rozvany, T.Sokół, V.Pomezanski, Z.Gaspar, Extension of Michell's classical (1904) truss topology optimization theory to multiple load conditions, stress and displacement constraints, space (3D) trusses, probabilistic design and discontinuous support conditions. In: M.Kleiber, T.Burczyński, K.Wilde, J.Górski, Ł.Smakosz (Editors), 3rd Polish Congress of Mechanics and 21st International Conference on Computer Methods in Mechanics, Short papers, vol.2, pp. 657-658, Gdańsk 2015, copyright by Polish Soc. Theor. Appl. Mech., Gdańsk Branch.

T. Sokół and G.I. N. Rozvany, On the numerical optimization of multi-load spatial Michell trusses using a new adaptive ground structure approach, 11th World Congress on Structural and Multidisciplinary Optimisation 07th -12th, June 2015, Sydney Australia

Sokół, T. On the Numerical Approximation of Michell Trusses and the Improved Ground Structure Method,, in Advances in Structural and Multidisciplinary Optimization, Proceedings of the 12th World Congress of Structural and Multidisciplinary Optimization (WCSMO12) eds. Schumacher A., Vietor T., Fiebig S., Bletzinger KU., Maute K., pp. 1411-1417, 2018 Springer International Publishing AG, doi.org/10.1007/978-3-319-67988-4, ISBN 978-3-319-67987-7,

<https://link.springer.com/book/10.1007/978-3-319-67988-4>

T.Sokół, On recent developments in ground structure methods, Conference IAMMC 2017) May 09 to 12, 2017 organized on the occasion of the 60th anniversary of signing an agreement concerning cooperation between Polish Academy of Sciences (PAN) and Centre National de la Recherche Scientifique (CNRS). Scientific Center of the Polish Academy of Sciences in Paris; 74, rue Lauriston - 75116 Paris The Conference website: <http://iammc2017.ippt.pan.pl/> . Org.: Centre Scientifique de l'Académie Polonaise des Sciences a Paris; Institute of Fundamental Technological Research, Polish Academy of Sciences.

T.Sokół, An improved ground structure method with adjusted displacements in empty zones CMM-2017, 22nd Computer Methods in Mechanics, September 13th–16th 2017 Lublin, Poland, eds. Burczyński T., Kuczma M., Warmiński J., Podgórski J., Błazik-Borowa E., Lipeccki T., Book of Abstracts MS01-43. ISBN 978-83-7947-264-2

T. Sokół: A new adaptive ground structure method for multi-load spatial Michell structures, pp. 525-528, , w: M.Kleiber, T. Burczyński, K. Wilde, J. Górski, K. Winkelmann, Ł. Smakosz (Red.), Advances in Mechanics: Theoretical, Computational and Interdisciplinary Issues. Taylor & Francis Group, London, ISBN 978-1-138-02906-4, CRC Press Balkema 2016

T.Sokół and T.Lewiński, Solution of the three force problem in a case of two forces being mutually orthogonal, 40th Solid Mechanics Conference, Warsaw, August 29th –September 2nd 2016. In: Z.Pęcherski, Ed.. Paper available online:

<http://solmech2016.ippt.pan.pl/Abstracts/0222.pdf>