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CONTENTS

SECTION 1. ARCHITECTURE

Jonas Abromas, Petras Grecevičius, Vytautas Dubra
Determining the Nature, Significance and Contrast of the Visual Impact to Landscape of Wind Turbines in Šilutė District..... 8

Monika Bartkutė, Vaiva Vaitkevičiūtė
Roof Development Ideas in Kaunas Old Town……. 9

Domenico Chizzoniti, Letizia Cattani, Luca Preis, Klizia Beggiora, Monica Moscatelli
Urban and Suburban Small-Scale Industrial Reuse. Strategies, Methodologies and Tools for Urban Regeneration in Small-Medium Towns……... 13

Raffaela De Martino, Rossella Franchino, Caterina Frettoloso, Nicola Pisacane
The Multicriteria Representation and Eco-Technological Survey of Compromised Territories: the Case Study of the Regi Lagni……. 14

Katarzyna Elwart, Małgorzata Sawicka
Revitalization of Medium Size Cities in Poland – Issues of Greenery and Prevention of Urban Sprawl…… 15

Franco Fidel
A Unified Vision of the Learning in Architecture. To profit the Funicular Line……..……..... 20

Dorota Gawryluk
Maintaining the Historical Forms and Constructions during Modernisation of 19th Century Russian Barracks in Zambrów (Poland)…… 24

Indrė Gražulevičiūtė-Vileniškė, Erika Zaleskienė
Theories of Landscape Aesthetics and their Application to Rurban Landscape……..…… 29

Petras Grecevičius, Jonas Abromas, Vytautas Dubra, Dovilė Kalkė
Urban and Territorial Aspects of the Development of the Recreational System of Lithuanian Seaside……..... 30

Kamilė Jakubauskaitė, Julius Blažys
Integration of Green Architecture into Urban Development in Lithuania……..... 31

Vilma Karvelytė – Balbierienė, Aušra Mlinkauskienė
Cultural Heritage and Social Environment Coherence in the Ethnographic Villages of Lithuania……..... 36

Martyna Kozak, Iwona Kluza
Non-visual Cityscape Changes in Accordance to the Garden-City Concept of Ebenezer Howard…… 37

Justina Mačiukėnaitė, Ingrida Povilaitienė
Identity Features of Spatial Structure in Small Cities, Towns and Villages in Dzūkija…… 42

Irina Matijošaitienė, Okyay Ucan, Armenui Minasyan
Cultural Differences in Landscape Perception…….. 43

Irina Matijošaitienė
Urban Crime in the City of New Haven: Residential Burglaries……... 44

Aušra Mlinkauskienė, Laura Jankauskaitė-Jurevičienė
Searching of Architectural-urban Expression at Recreational Infrastructure Objects While Developing River Tourism……... 45

Berrin Sahin Diri
Assessment of Sub-Systems and Sustainability of Ten Buildings Constructed in Istanbul……..……..… 46

Gitana Šukaitytė, Rėda Bistrickaitė, Lina Vaičiulionienė, Darius Visockis, Aurimas Bartkus
"EKOLAVIŠKIS – the Five Farmstead Village" – Creation of Sustainable Architecture……...…… 56

Lory Zakar, Özlem Eren
Importance of Integrated Design in Sustainable Architecture……..…… 61

Kęstutis Zaleckis, Giedrė Gudzinevičiūtė-Vilkelė
Identification of Urban Central Places (Kaunas Case)……...……...……... 69

SECTION 2. BUILDING MATERIALS

Ruben Paul Borg
Life Cycle Assessment of Aggregate: A Review…….……...……. 70

Girts Frolovs, Karlis Rocens, Janis Sliseris
Numerical Investigations of Composite Plywood Plates with Vertically Placed Waved Ribs…….…. 71

Paulius Grigaliūnas, Žymantas Rudžionis
Investigation and Comparison of SCFRC Properties Incorporated the Fly Ash and Zeolitic Additives.. 78

Patricija Kara
Application of Waste Glass Powder in Foamed Concrete……...…….. 79

Andrius Kielė, Vitoldas Vaitkevičius, Vytautas Sasnauskas, Danutė Vaičiukynienė, Rėda Bistrickaitė
Effect of Reinforcement Corrosion Degree on Concrete Properties…….……...…. 80

Albertas Klovas, Mindaugas Daukšys, Ignacio Villalon Fornes, Šarūnas Bertašius
The Insights of Formed Concrete Surface Quality Evaluation Using Open Source Software "ImageJ". 81

Aleksandrs Korjakins, Liga Upeniece, Liga Tomase
Improving Mechanical Properties of Porous Ceramics by Controlling Size of Porosity……...…….. 86

Małgorzata Lelusz, Marta Kosior-Kazberuk, Walery Jezierski
Fly Ash and Air-Entraining Admixtures Influence on Compressive Strength of Cement Mortars…..... 87

Nikolai Prokopchuk, Tatyana Kukhta
Study of Longevity Evaluation Criteria of Polymeric Coatings……. 92

Maris Sinka, Genadijs Sahmenko, Aleksandrs Korjakins
Mechanical Properties of Pre-compressed Hemp-lime Concrete……. 97

Alexandr Shimanovsky, Volha Yakubovich
Computer Modelling of Contact Interaction between Cement Matrix and Filler Grains in the Concrete Structural Element…….……...……... 98

Andina Sprince, Leonids Pakrastinsh, Aleksandrs Korjakins
Behaviour of Fibre Reinforced Cement Based Composites……...…… 103

Ieva Striūgienė, Antanas Kaziliūnas
Influence of Long-Term Storage Portland cements on Exploitation Properties of Cement Mixes……..... 108

Evaldas Šemelis, Jurgita Malaiškienė, Viktor Kizinievič
Vibropressed Concrete Physical, Mechanical Properties Dependence on Coarse Aggregate Type…... 113

Evaldas Šerelis, Mariangela Deligia, Vitoldas Vaitkevičius, Vidas Kerševičius
Influence of Water to Cement Ratio with Different Amount of Binder on Properties of Ultra-High Performance Concrete……..…… 114

Evgeniya Uretskaya, Elena Plotnikova, Vadim Melenko
Experience in Manufacture and Application of Lightweight Plasters Based on Gypsum Binders in Construction……... 115

Abdellah Zerroug, Egils Dzelzitis, Anatolijs Borodinecs
Study of the Feasibility of Using Blended Soils to Make Stabilized Pressed Earth Blocks in Sétif

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Application of Waste Glass Powder in Foamed Concrete

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EXTENDED ABSTRACT

Foamed concrete is an increasingly popular material for diverse construction applications, from thermal/acoustic insulation and building elements to mine reinstatement and ground stabilization. Current research is aimed at developing a glass foamed concrete using high-speed disperser developed at Riga Technical University (Latvia) in 2011 (Mironovs et al., 2011) with optimal pore distribution while improving the structural and thermal properties. Cavitation treatment of pozzolanic materials before concrete mixing is proposed in (Justs et al., 2012) in order to disaggregate agglomerated particles, to reach better particle dispersion in concrete mixture along with surface activating proved to be simple, fast and effective way to improve concrete mixture properties. Recently, foamed concrete has been designed utilizing (i) fly ash as sand or filler aimed to achieve uniform distribution of the air bubbles (Jones and McCarthy, 2005), (ii) polypropylene fibers were used to improve the compressive strength, tensile strength and increase the drying shrinkage resistance (Bing et al., 2011), and in the present research waste glass powder was used to substitute Portland cement. Waste glass powder was obtained from incandescent light bulb chips which were ground for 30 minutes into powder in laboratory planetary ball mill Retsch PM400 (with rotation speed 300 min^{-1}).

There are no standard methods for proportioning foamed concretes therefore the first set of the experiments was hold on finding right proportion of the components of the mixture with lower as possible water/cement or water/binder ratio which could guarantee the necessary flow of foamed concrete mortar and it's creamy consistency in the high-speed disperser with angular rotation speed from 0 to 9000 rpm. The w/c ratio for the foamed concretes was maintained at 0.43 as a basis of comparison and because it provided sufficient consistence for the majority of mixtures within the range of densities and constituent materials considered. To examine the influence of foam content on the properties of foamed concrete, three grade densities, 600 kg/m^3, 800 kg/m^3 and 1000 kg/m^3 were designed using different foam volume fractions. Test specimens were cast by hand compaction only. Cubic 50x50x50 mm and prismatic 40x40x160 mm specimens were prepared in order to determine compressive and bending strength. Slab specimens 350x350x50 mm were prepared in order to determine thermal conductivity. The consistence of foamed concrete was assessed in terms of slump flow spread and was measured by means of cylinder.

Compressive strength tests were conducted on Controls (model 50-C56G2) semi-automatic compression machine (3000kN). The compressive strength of concrete specimens was determined at the age of 28 and 56 days in accordance with LVS EN 12390-3:2009/AC:2011 and three specimens were tested at each age. The flexural strength tests were conducted on МИИ-100 ("Редуктор", 1965). Physical properties of hardened foamed concrete samples like density (LVS EN 12390-7:2009), water absorption and thermal conductivity were defined. Keyence corporation VHX-2000 optical microscope with lens VH-Z20R/W was used for optical imaging and air-void distribution analysis.

The difficulty of present investigation was to obtain low thermal conductivity, for which the presence of void space should be suitable, and a high mechanical strength, for which matter instead of void space was needed. Another risk was to obtain poor mixtures distribution and segregation but application of high-speed disperser reduced that risk. The use of waste glass powder in foamed concrete benefited compressive strength development, particularly after 28 days as cement substitute at level of 20% and as filler. In total the compressive strength results varied from 3 to 14 MPa corresponding to concrete densities from 600 to 1000 kg/m^3 and thermal conductivities 0.19 – 0.23 W/mK.

Keywords: *foamed concrete, waste glass powder.*

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