



**UNIVERSITATEA „DUNĂREA DE JOS” DIN GALAȚI**  
**Școala doctorală de Inginerie mecanică și industrială**

# **HABILITATION THESIS**

## **ABSTRACT**

**CONTRIBUTIONS TO THE DEVELOPMENT AND  
INNOVATION OF PROCESSES FOR OBTAINING  
ASPHALT MIXTURES IN THE ROAD CONSTRUCTION  
INDUSTRY**

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## **A.1. Abstract**

The habilitation thesis entitled "Contributions to the development and innovation of asphalt mixtures in the road construction industry" presents a summary of the most important scientific results obtained after defending the doctoral thesis at the "Dunărea de Jos" University of Galați on 30.11.2007, based on the competencies acquired after graduating the Faculty of Mechanics (2002) and the Faculty of Economics (2008).

The thesis is elaborated in accordance with the minimum and obligatory standards specific to the field of doctoral studies in Industrial Engineering and according to the Regulation on obtaining the habilitation certificate at the "Dunărea de Jos" University of Galați.

The theme of empowerment commits me to develop as an individual in a world based on knowledge, in which education and scientific research play a key role and represent the scientific results published after the last promotion to the teaching degree in 2016.

The thesis is structured in three chapters. Chapter B.1. briefly presents fundamental aspects related to the related to waste management with opportunities for recovery in industry, especially in the road construction industry. The own results obtained in this field are presented in chapter B.2. The last chapter (Chapter B.3.) discusses career development plans and research directions in industrial waste management in which the author wants to continue and develop research in case of coordinating doctoral theses in the field of Industrial Engineering.

The results presented in the paper were obtained by the author in national and international research projects as project director or responsible partner.

### **Chapter B.1. Fundamental aspects of waste management with opportunities for recovery in the road construction industry**

The concept of sustainable development involves the restructuring of the use of natural resources, so that economic activities are in balance with ecological systems, in order to avoid the full consumption of these resources. Waste management aims to reduce pollution and save natural resources with opportunities in the road construction industry, especially in Galati County, known as an industrial area supported by the shipyard, the plant and the company in road construction. Shipyards are known to be heavy consumers of blasting materials for finishing metal surfaces in construction, often using quartz sand or fine sorting of quartz stone sieve, raw materials that require in addition to the presence of potential sources in nature and their processing for activation. characteristics required by blasting operations. On the other hand, it is the companies that make bitumen-based asphalt mixtures with the dispersion of quartz aggregates, being large consumers of these raw materials, but which are liable to be

replaced by grit waste sorting from sandblasting. A great advantage of the waste grit in such uses is the high concentrations in the leachate component, resistant to mechanical and climatic/chemical wear in the asphalt blanket.

The use of quartz sand blasting operations to clean the hulls both in the installation and in the restoration and repainting of old vessels, allows the removal of all surface impurities, in the form of corrosion products, of existing paint coatings, of the salts deposited by recrystallization, as well as of the algae deposits, of the gastropod / bivalve formations, etc. If the quality characteristics of the grit are not observed, the cleaning of the metal surface is compromised. A strong influence on the performance of sandblasting processes is the influence of any existing contaminants on cleaned surfaces, but also the quality of abrasive particles that will give the optimal surface roughness according to standards.

In our country, but also abroad, shipyards have problems with the acquisition and processing, but also with the need for blasting materials, also facing the issues of large areas of waste storage and environmental protection measures, because the light fractions they often form very harmful flying dusts. Moreover, the use in the process of sandblasting the grit, it turns into a hazardous waste over time, because it also contains traces of heavy metals, in the form of dirt or metal oxides, paint residues or other protective films, which have compounds such as polychlorinated biphenyls (PCBs). Under these conditions, reducing the level of pollution in the naval sector, by increasing the degree of recovery of all categories of waste and their controlled storage, is a priority in the environmental policy of the Southeast of Romania.

In contrast, asphalt mixers, in addition to being energy-intensive, are also polluting, but have the advantage that many of the types of fillers, derived from natural raw materials, can be successfully replaced by the use of waste from operations. blasting or falling from pottery factories. The limitation of resources and climate problems require us to move from 2050 to the traditional-linear economic model based on the equation of extract-consume-throw, to a completely circular, sustainable economy with multiple possibilities for recovering as much waste as possible.

### **Chapter B.2. Scientific contributions to waste recovery in the road construction industry**

include its own results in improving asphalt mixtures by waste recovery, as well as their analysis from the point of view of Marshall characteristics.

A first study consisted in the recovery of waste from the shipbuilding industry (Galați Shipyard), from the cleaning of the hulls to the commissioning and the restoration and repainting of old vessels, which has not been reported in Specialty literature. Regarding the used grit, it was cleaned in order to eliminate soluble salts and granulometric analysis on sorts to highlight the behavior of bitumen dispersion for use in asphalt mixtures. Based on the

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Applied Research Contract no. 45/22.11.2018 „Scientific research and technological consultancy services” for S.C. TANCRAD SRL aimed to obtain a new asphalt mixture recipe by partially replacing natural quartz sand with waste grit with similar granulometry (0.1-2.0 mm) and optimizing the bitumen content. New recipe for hot asphalt mixture type BA 8 obtained according to SR 174-1 / 2009 was tested with Marshall test (stability (S) at 60 ° C, flow rate, S / L ratio, bulk density, absorption of water). The introduction of the waste grit in the hot asphalt mixture results in the improvement of the physical-mechanical characteristics, especially the wear resistance, but also the reduction of the impact of the industrial activities on the quality of the environment. The results obtained were materialized by publishing ISI-listed papers and participating in scientific communications. The optimized recipe brings a number of benefits, such as significant progress towards sustainable development, by reducing the impact on the environment using efficient and responsible natural resources awarded the Gold Medal at the International Invention Innovation Competition in Canada (2019).

Starting with 2020, together with a group of researchers from the “Dunărea de Jos” University of Galați and with specialists from the Tancrad Society, we approached a new research direction regarding the possibilities of introducing of microplastics (plastics smaller than 5 mm in size) in the optimized recipe of the asphalt mixture which continues the research activity previously presented. Microplastics are a worldwide concern due to the negative effect on the environment and thus on human health. The optimized recipe of the hot asphalt mixture type BA 8 with waste grit and microplastics based on polypropylene has a number of advantages such as: reducing the cost of asphalt mixtures by using a smaller amount of bitumen; reducing the risk of micro/macro cracks in asphalt mixtures due to temperature variations and contact with the material used as a non-slip material and improving the Marshall characteristics compared to the standard recipe of the asphalt mixture studied. and is the subject of the patent entitled "*Improving asphalt mixtures with waste scrap and microplastics*”(Patent A00119 / March2021), in collaboration with SC Tancrad which made possible the transition from experimental to applied research.

Another study focused on the current environmental problem, which is the enormous amount of surgical masks used by World Health Organization measures to make masks mandatory in public due to the context of the global COVID-19 pandemic, stored uncontrolled in the environment (no one was prepared for efficient management of surgical mask waste management). The research consisted in the recycling of surgical masks by introducing / incorporating them in the recipe of the hot asphalt mixture of bituminous asphalt type with chipping for base layer AB 31.5 in order to eliminate the risks of pollution caused by used surgical masks stored uncontrolled worldwide following the COVID-19 pandemic. In the

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experimental tests performed in the Laboratory of Analysis and tests in construction - Grade II surgical masks were used (worn surgical masks can not be performed in the laboratory due to public safety measures of the activity in health safety on measures to prevent contamination with SARS-COV-2). Worn masks with a risk of contamination when introduced into the pouring mixture (160 °C) do not present any danger of soil / population contamination due to the fact that at 130 °C the sterilization process takes place, the masks become inert. The results of these researches were materialized in the elaboration and obtaining of a second patent OSIM Nr. A 2021 00468, BOPI 12/2021.

**Chapter B.3. Directions for academic development and research.** The development of the future scientific career will be done on the directions developed so far, but also by identifying new directions.

Some of the new research directions aimed at industrial waste management are the basis of ongoing research projects:

**1. Biomass waste management-** improving caloric properties with the potential of reed in industry by developing innovative technologies using artificial intelligence- in progress SECTORIAL Project 2021.

**2. Disposable slag management** - developing new approaches on slag disposal waste management in line with AGENDA2030 presenting an action plan to promote the transition to a more sustainable model known as the circular economy, a production and consumption model involving the sharing, reuse, repair, renovation and recycling of materials and products existing as much as possible.

**3. CO<sub>2</sub> emissions management-** a new trend research direction led to the filing of the third patent, classing the “Dunărea de Jos” University of Galați into a modern, competitive and resource-efficient economy. The Green Deal aims to achieve zero net greenhouse gas emissions by 2050, with research in the patent filed in December 2021 entitled "*CO<sub>2</sub> sequestration method using white slag and carbide slag mixture*".

**4. Waste management in the pharmaceutical industry** - aims at new research directions on the possibilities of capitalizing on plastics from expired medical waste - 2 in progress research contracts with the economic environment.

My future PhD students will also participate in these activities, but also in research and development projects. Given the huge potential of efficient and responsible use of natural resources to reduce the impact on the environment, I intend to further promote the recovery of waste by reintroducing it into industry.