Nonmetallic Excellence and Innovation Center for Building Materials (NEXCEL) 2022 Program Guideline

Nonmetallic Excellence and Innovation Center for Building Materials (NEXCEL, hereinafter referred to as the Center) is a technology R&D institution co-founded in January 2022 by Saudi Aramco, the world's largest energy and chemical producer, and China Building Materials Academy (CBMA). The Center will be committed to promoting the application of nonmetallic materials in the building and construction sector, and providing more sustainable building and construction solutions. Compared with traditional materials used in construction, nonmetallic materials, including petroleum-based advanced composite materials, are more durable and less expensive to maintain, and will play an important role in boosting the development of low-carbon building and infrastructure construction in China.

NEXCEL is the first Nonmetallic Innovation Center established by Saudi Aramco in Asia. The Center aims to expand and accelerate nonmetallic technology deployment in the building and construction sector by carrying out research and development and publicity of nonmetallic material technology, developing and promoting nonmetallic material standards and regulations, training technical talents for the development and application of nonmetallic materials technology in the field of building and construction.

According to the strategic positioning and development goals of the Center, the Center will carry out scientific and technological innovation tasks in seven fields, including waterproofing and repair materials, insulation and composite cladding, special mortars and concrete, flooring and pavement for road and bridges, fibers, rebars and fiber composites, admixtures and construction chemicals, paintings and others.

Below is a guideline to the major supporting projects by NEXCEL in 2022.

1. TDA Program

1.1 Comprehensive Promotion and Improvement of FRP Reinforced Composite Materials and Engineering Structural Members

Research content: Methodological and theoretical studies of enhancing the modulus of elasticity and connectivity of fibre composite materials for civil engineering structure; Develop designing method and manufacturing technology of fibre composite material resins and section materials with high ductility and large deformation capacity; Key technologies and designing methods of ductile composite materials' structures; Develop composite material components with high fire resistance; Study the creep behavior of fiber reinforced composites.

Assessment indicators: Proposal for enhancing 1 or 2 joint nodes of pultrusion of fibre composite materials; Develop fiber composite material resins with ultimate tensile strain no less than 2.5% and post yield strain no less than 1%; Develop composite profiles with in-plane shear strength no less than 50 MPa and equivalent tensile strength no less than 80% of conventional unidirectional composite profile; Enhance the overall performance of composite structural parts that the efficiency of material strength is not less than 75% and ductility factor greater than 3.0 at the ultimate state; The fire protection grade of the material reaches B1, and the fire resistance limit of the horizontal load-carrying parts is greater than 1 h; Develop design methods for highly-ductile composite structure parts, and formulate at least one standard (group standard level or above, draft for review); Apply for no less than one patent of invention; Publish relevant theses $\geqslant$2(including SCI/EI English thesis $\geqslant$1); Conduct one project demonstration.

Number of funded projects: 1

Funding: within 800,000 RMB

Project duration: 2 years

1.2 Mixture Performance Improvement and Engineering Demonstration of Mechanical Foaming Warm-mixed Asphalt

Research content: Study the influence of chemical composition, temperature, water consumption and other factors from different asphalt varieties (including asphalt produced from Aramco crude oil) on the foaming characteristics of asphalt and propose production process of foamed asphalt with the optimum foaming characteristics; Develop or optimize economical hydrocarbon-based polymer asphalt

admixture, study the enhancement effect of additives on asphalt-aggregate interface performance, improve the water resistance and low temperature performance of warm-mixed asphalt mixture; The verification of high and low temperature, moisture damage resistance and fatigue performance for indoor warm-mixed asphalt and asphalt mixture; Establish a demonstration project of foamed asphalt warm-mixed mixture to verify the pavement performance.

Assessment indicators: Compared with same-type hot mix asphalt mixtures, the construction temperature can be reduced by 20°C or more, water resistance and low temperature performance are higher than that of hot mix asphalt mixtures, and other properties are equivalent; The cost of additives per ton of asphalt mixture is less than 10 RMB; 2 to 4 demonstration projects are paved, the total mileage is no less than 10 km; formulate one standard (group standard level or above, draft for review), and apply for no less than one patent of invention; Publish relevant theses $\geqslant$2(including SCI/EI English thesis$\geqslant$1); The achievements reach the international advanced level.

Number of funded projects: 1

Funding: within 800,000 RMB

Project duration: 2 years

1.3 Investigation of Dosage of Admixtures on Concrete Durability and Cost and Development of New Type Water Reducing Admixture

Research content: Design hydrocarbon-based polymer functional groups and achieve high conversion rate for the preparation of marcomonomers. Through graft copolymerization and control of graft points and side chain density, etc., in order to improve steric effect, prepare polycarboxylic acid superplasticizer with high dispersibility and good adaptability as well as UHPC concrete material with ultra high performance, and elaborate the mechanism of achieving high dispersion in ultra-low w/c ratio systems. Compared with the traditional polycarboxylic acid superplasticizer, study the effects of different dosages of highly dispersed polycarboxylic acid superplasticizers on cement dosage, w/c ratio, durability, carbon emission reduction and cost in C30~C50 concrete.

Assessment indicators: For highly dispersed polycarboxylic acid superplasticizer, the w/c is 0.18, the fluidity of cement paste is $\geqslant$200 mm; The water

reduction rate of concrete is ⩾ 40%, and air content is ⩽ 3.5%; Applied in typical UHPC materials, the compressive strength of the prepared UHPC materials ⩾ 120 MPa; Develop 1 large-scale production line of highly dispersed polycarboxylic acid superplasticizer and complete 1 demonstration project.

For traditional PCE superplasticizer, increase the admixture dosage to reduce cement content by 15% ~ 20%, and reduce water content by 25% while keeping the same slump of C30 ~ C50 concrete. Apply for no less than two patents of invention and publish relevant theses ⩾ 2 (including SCI/EI English thesis ⩾ 1); The achievements reach the international advanced level.

Number of funded projects: 1

Funding: within 800,000 RMB

Project duration: 2 years

1.4 Development and Demonstration of Composite Tower for Communication Towers and Power Transmission for over 15 Meters

Research content: Study the key technology and performance evaluation of composite lattice tower structure design for communication and power transmission; Explore the optimization and performance evaluation method of reinforcement and matrix material of composite lattice tower for communication and power transmission; Research on the functional integration technology of composite lattice towers for communication and power transmission with low maintenance costs; Study of new connecting structures of composite lattice towers; Develop and demonstrate key technologies of easy installation of composite lattice towers.

Assessment indicators: After 100 freeze-thaw cycles, the retention rate of tensile strength, compressive strength and bending strength for lattice tower is no less than 95%; The lattice tower materials meet the combustion performance grade B1; The total mass of the composite lattice tower is reduced by over 25% compared with the same type of metal tower; Achieve the ratio of metal connectors being ⩽ 10% out of the total mass of the lattice tower, and the single-piece mass of the composite lattice tower components ⩽ 60 kg, and the connection strength ⩾ 50 MPa; Apply for no less than one patent of invention in China or abroad and publish relevant theses ⩾

2(including SCI/EI English thesis ⩾1); Formulate one standard (group standard level or above, draft for review); Conduct one project demonstration.

Number of funded projects: 1

Funding: within 800,000 RMB

Project duration: 2 years

2. Small Fund Program

2.1 Research on 3D Printing Polymer Modified Concrete and Its Interface Reinforcement Technology

Research content: Study the influence of petroleum-based polymers on the rheology and printability of cement concrete, and develop 3D printable polymer modified concrete; Study the effects of organic polymer fibers on the interface and mechanical properties of 3D printed polymer modified concrete, and the synchronous spraying technology of polymer emulsions between interfaces, and clarify the influence of polymer emulsions on interface binding properties. Study the application technology of petroleum-based rebars synchronous enhancement of interfacial strength and achieve the enhancement of interface and overall mechanical properties of 3D printed polymer modified concrete with demonstrations.

Assessment indicators: Develop at least one type of polymer modified concrete ink material for 3D printing with polymer emulsion dosage being ⩾20% and organic fiber volume ⩾ 1.5%; Compared with the reference mix, the average compressive strength of 3D printed polymer modified concrete after interface enhancement is no less than 120%, and the average flexural strength is no less than 120%; Formulate one standard (group standard level, draft for review); Apply for no less than one patent and publish no less than 1 thesis; Complete at least one piece of 3D printing polymer modified concrete building sample.

Number of funded projects: 1

Funding: within 300,000 RMB

Project duration: 1 year

2.2 Research and Demonstration Application of Admixtures for (ready-mixed fluid) Solidified Soil

Research content: Study the effect of various functional components such as dispersing components, curing components, volume-stabilizing components, superplasticizers and adhesives (ethylene and other petroleum cracking products such as redispersible latex powder, with a dosage of 5-40 kg/t) on the fluidity, compressive strength, and water stability coefficient of the cured soil; Investigate the action mechanism of the admixture for ready-mixed fluid-solidified soil; Determine the composition system of the admixtures for fluid-solidified soil, and conduct large-scale production; Develop a complete set of application technologies for ready-mixed fluidized solidified soil that meets different construction process and environment requirements in terms of different soil compositions such as soil, sand, construction waste soil, etc.; Conduct application demonstration, economical and environmental impact analysis.

Assessment indicators: Performance index of highly fluidized solidified soil mixed with admixtures: The slump is no less than 240 mm; The 28 d compressive strength of solidified soil is no less than 1.0-10 MPa; The coefficient of water stability is no less than 110%; Apply for no less than one patent of invention and publish no less than two relevant theses. Build a large-scale production line of admixtures for fluidized solidified soil; Conduct fluidized solidified soil demonstration.

Number of funded projects: 1

Funding: within 250,000 RMB

Project duration: 1 year

2.3 Engineering Demonstration and Evaluation of In-situ Recycling of Waste Asphalt with Polymer-based Admixture

Research content: Study water stability, high-temperature stability, low -temperature crack resistance, fatigue resistance of recycled asphalt mixture and their correlation with the performance of road surface; Research and develop petroleum-based functional additives for the recycling of waste asphalt pavement, and explore its mechanism; Study the construction process of in-place recycled asphalt mixture and make demonstration of road pavement to verify its performance.

Assessment indicators: The performance of the in-place recycled asphalt mixture is not lower than that of the new asphalt mixture of the same type; Reduce paving temperature by more than 30℃; The mileage of the demonstration project

reaches at least 5 km; Formulate one standard (group standard level or above, draft for review) and apply for no less than one patent of invention and publish no less than one thesis.

Number of funded projects: 1

Funding: within 200,000 RMB

Project duration: 1 year

2.4 Engineering Demonstration and Evaluation of the Prefabricated Composite Wall Panel Made of Recycled Expanded Polystyrene Insulated Concrete

Research content: Using recycled polystyrene particles as aggregates, the working properties of insulated concrete mixtures prepared with foamed cementitious materials and changes in the physical and mechanical properties of hardened concrete are systematically studied. Research on the composite technology of recycled polystyrene particle insulation concrete and silicon calcium board, and prefabricate insulation concrete composite panel made of recycled polystyrene particle, which is used for the partition wall or composite exterior wall's insulation layer in construction project and compared with the performance and cost of virgin EPS insulation panels and existing conventional panels; Research on the assembling technology of prefabricated insulation concrete composite panel made of recycled polystyrene particles, and achieve a large-scale application of demonstration projects.

Assessment indicators: The proportion of recycled polystyrene particles in insulation concrete is not less than 50%; The combustion performance of insulation concrete is not lower than B1 level; Prefabricated insulated concrete composite panel of recycled polystyrene particles (taking 90 mm thickness plate as an example), its surface density is $\leqslant$ 80 kg/m^2, bending strength of crushing load/plate weight multiple $\geqslant$2, heat transfer coefficient $\leqslant$ 2.0 W/m^2·K; Compared with the virgin EPS insulation panels and existing conventional panels, the heat insulation performance increase by 10% and the costs drop by 10% whereas flame retardancy remain undropped. Apply for no less than one patent of invention and publish no less than one thesis. Formulate one standard (group standard level, draft for approval); Demonstration project covers an area of no less than 2,000 m^2.

Number of funded projects: 1

Funding: within 200,000 RMB

Project duration: 1 year

2.5 Study on Improving the Performance of Inferior Coarse Aggregate with Polymer Modification

Research content: Study and analyze causes for the poor performance of inferior coarse aggregates, and develop relevant performance evaluation methods and systems. Develop pre-treatment and polymer modification technology for inferior coarse aggregate to improve the performance of inferior aggregate and realize its application in concrete. Reveal the influence and mechanism of inferior coarse aggregate on the performance of freshly mixed concrete, and explore key technologies for the application of inferior coarse aggregate.

Assessment indicators: Achieve a loss rate of soundness $\leqslant$ 10% in polymer-modified inferior coarse aggregates, the decline of water absorption rate $\geqslant$ 20%, and a $\geqslant$30% reduction in the adsorption ratio of the admixture; The initial slump degree of polymer-modified inferior coarse aggregate concrete is increased by $\geqslant$30%, and the 1 h slump retention value increased by $\geqslant$40%, and the compressive strength of 28 d increased by $\geqslant$10%; Apply for no less than one patent and publish no less than two theses; Form key technology of inferior coarse aggregate application, and complete one engineering application demonstration.

Number of funded projects: 1

Funding: within 250,000 RMB

Project duration: 1 year

2.6 Ph.D Training Program

Research content: The research content of the project is consistent with the research topic of the doctoral students; The project should focus on the application of petroleum-based materials in the fields of architecture, building materials and construction; The project is jointly applied by the supervisor and a doctoral student, and the number of projects applied by each supervisor is limited to one, and the doctoral students are two years away from the graduation date.

Assessment indicators: Publish at least two SCI papers (collected or published in journals); Deliver at least one oral presentation (doctoral report) in national or industry conferences; Final project report.

Number of funded projects: 3

Funding: within 100,000 RMB per project

Project duration: 2 years

2.7 Advocacy or Training Projects

Advocating or training content: Application of petroleum-based materials in the field of building materials and construction and its catalyst effect in large-scale application in building and construction.

Assessment indicators: More than 1,000 professionals who have received publicity or training; Final publicity or training report.

Number of funded projects: 3

Funding: within 100,000 RMB per project

Project duration: 1 year

3. Applicant Requirements

3.1 All projects are open to the public for solicitation, and only outstanding applications are to be selected. The applicant must meet the application requirements of the project, and has to be an on-the-job professional and technical personnel.

3.2 The applicant must be the actual person in charge of the project, formally employed by the main undertaking unit of the applied project, and ensure sufficient time and energy to engage in the research of the applied project.

3.3 During the implementation of the project, each applicant can only undertake one project of the Center. Applicants who have undertaken the project funded by the Center as the project leader and have not yet completed the project will not be further funded in principle.

3.4 The applied TDA and demonstration projects should have innovative academic ideas, clear scientific issues, feasible research routes or technical solutions, prominent research priorities, and explicit assessment objectives.

4. Application Procedures and Instructions

4.1 The applicant shall download the "NEXCEL Project Application Form" on www.non-metallic.net (find Download Section), and fill in it carefully and truthfully based on prescribed format.

4.2 The project proposal must be reviewed, signed and stamped by the applicant's affiliation before submission.

4.3 All project applications must submit the electronic form and the original paper form (in duplicate). The content of the electronic and the paper proposal must be consistent. Attachments that are difficult to digitize should be submitted together with the paper proposal. For all written documents, please use double-sided printing on A4 paper and ordinary paper materials as the cover. No binding methods such as perfect binding and folders are required.

4.4 All documents will not be returned regardless of whether the application project is approved or not. Applicants are requested to back up the original application documents.

4.5 The project review and management of the Center shall be carried out in accordance with the “NEXCEL Program Management Regulations”.

4.6 Applications for all projects in 2022 will be accepted from April 6 to May 5, 2022 (postmarks shall prevail for postal applications).

4.7 Any papers, books and software copyrights produced during the implementation of projects funded by the Center are jointly owned by the Center and the author, and are marked with the NEXCEL title and project number. Standards and patents are owned and signed by the inventor, CBMA, Saudi Aramco (ABS and/or its affiliates).

5. Contact Us

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