

## TECHNICAL REVIEWERS' COMMENTS

### LRC-LXXVI(76)-A:

#### “Investigating the Use of Fly Ash and Nanomaterials for Sustainable Concrete Infrastructure”

Submitted by: University of North Dakota Department of Civil Engineering;

Request for: \$14,559; Total Project Costs: \$60,642;

Principal Investigator: Daba S. Gedafa, Ph.D., P.E.

### 1. OBJECTIVES

The objectives or goals of the proposed project with respect to clarity and consistency with Industrial Commission/Lignite Research Council goals are: 1 - very unclear; 2 - unclear; 3 - clear; 4 - very clear; or 5 - exceptionally clear.

#### **Reviewer 13-10 (Rating: 4)**

The main objective of this project is to test the hypothesis that ordinary Portland cement can be fully replaced by fly ash and nanomaterials in concrete. In addition, four specific objectives are listed on page 1 of the proposal. The main and specific objectives are consistent with the NDIC/LRC goal to develop and demonstrate the use of marketable lignite byproducts. The objective could be more clearly linked to NDIC/LRC goals by relating the use of ND lignite fly ash to jobs, and economic benefits to the State.

#### **Reviewer 13-11 (Rating: 3)**

The increased use of lignite-derived fly ash is a benefit to the lignite industry and can be a cost offset rather than a cost burden.

#### **Reviewer 13-12 (Rating: 4)**

The project is certainly eligible by researching and developing products using ash derived from lignite. If the specific objectives are met, then a conclusion can be made to determine if fly ash and nanomaterials can totally replace cement. The alternative objective of determining the maximum amount of ordinary Portland cement that can be replaced by fly ash and nanomaterials is a valid conclusion as well.

### 2. ACHIEVABILITY

With the approach suggested and time and budget available, the objectives are: 1 - not achievable; 2 - possibly achievable; 3 - likely achievable; 4 - most likely achievable; or 5 - certainly achievable.

#### **Reviewer 13-10 (Rating: 4)**

The standard of success for achievement of the project objectives (see proposal p-14) are fairly modest. The qualifications of the PIs and the proposal are of high quality demonstrating a high project management ability. The objectives measured by the standard of success are most likely achievable.

**Reviewer 13-11 (Rating: 3)**

The nanomaterial concentration will be increases at 0.5% until properties equivalent... What is the anticipated concentration that will need to be used? If it is too high, numerous tests will need to be conducted that will require a lot of time and budget, which may lead to the project going over budget and not meet the time requirements. The amount of work also seems ambitious with respect to the budget and time frame.

**Reviewer 13-12 (Rating: 5)**

The approach is well designed technically.

3. **METHODOLOGY**

The quality of the methodology displayed in the proposal is: 1 - well below average; 2 - below average; 3 - average; 4 - above average; or 5 - well above average.

**Reviewer 13-10 (Rating: 5)**

Technically, the quality of the methodology displayed in the proposal is well above average.

**Reviewer 13-11 (Rating: 3)**

Overall, the methodology is sufficient. I would have preferred to see a more detailed test matrix with anticipated maximum and minimum nanomaterial additive ranges instead of “until desired results are obtained.” I would like to see some sort of economic analysis to see if the optimum fly ash and nanomaterial blends are cost effective compared to traditional Portland cement or currently used cement/fly ash blends.

**Reviewer 13-12 (Rating: 5)**

The methodology is strong and supported by excellent testing equipment and state-of-the- art laboratory facilities.

4. **CONTRIBUTION**

The scientific and/or technical contribution of the proposed work to specifically address Industrial Commission/LRC goals will likely be: 1 - extremely small; 2 - small; 3 - significant; 4 - very significant; or 5 - extremely significant.

**Reviewer 13-10 (Rating: 4)**

The technical contribution of the proposed work could be extremely significant. How the scientific and technical contributions specifically address NDIC/LRC goals may or may not be extremely significant.

**Reviewer 13-11 (Rating: 2)**

This project has the potential to benefit the utilities that sell their fly ash for concrete use. The proposal did not mention which fly ash classes this technology could be applied to and did not mention if this would offer a cheaper alternative to currently used technologies. Also, with respect to current and pending regulations, there are much more pressing needs such as CO2 technologies and the MATS rule that are more pressing funding needs.

**Reviewer 13-12 (Rating: 4)**

Several of the North Dakota Industrial Commission goals will be met including development and demonstration of marketable lignite byproducts and beneficial impact of reducing landfill wastes.

5. **AWARENESS**

The principal investigator's awareness of current research activity and published literature as evidenced by literature referenced and its interpretation and by the reference to unpublished research related to the proposal is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

**Reviewer 13-10 (Rating: 5)**

This proposal request is for a relatively modest \$14,559. The technical, scientific and project management detail is superior to most of the largest NDIS/LRC proposal requests known to this reviewer. The proposal contains extensive use of published and cited literature.

**Reviewer 13-11 (Rating: 4)**

The PI seems to have a good understanding of fly ash usage in the construction industry.

**Reviewer 13-12 (Rating: 5)**

The principal investigator has included substantial references of research activity and published literature.

6. **BACKGROUND**

The background of the investigator(s) as related to the proposed work is: 1 - very limited; 2 - limited; 3 - adequate; 4 - better than average; or 5 - exceptional.

**Reviewer 13-10 (Rating: 5)**

The background if the PIs as related to the proposed work is exceptional. The PI has extensive experience in the laboratory, classroom and in practical application.

**Reviewer 13-11 (Rating: 4)**

The PI has an extensive background in pavement research and the use of alternative materials research in pavement applications.

**Reviewer 13-12 (Rating: 5)**

Highly qualified.

## 7. PROJECT MANAGEMENT

The project management plan, including a well-defined milestone chart, schedule, financial plan, and plan for communications among the investigators and subcontractors, if any is: 1 - very inadequate; 2 - inadequate; 3 - adequate; 4 very good; or 5 - exceptionally good.

### **Reviewer 13-10 (Rating: 4)**

The project management plan is very good. This reviewer would like to have seen a milestone chart. The timetables and details are provided in the text but visual depiction is helpful. Do the chart and graphs exist?

### **Reviewer 13-11 (Rating: 1)**

No project management plan is presented and there is no discussion of milestones, etc. This must be addressed.

### **Reviewer 13-12 (Rating: 4)**

The team is small in size, the principal investigator and one graduate assistant, the reporting is adequate and the financial plan seems reasonable and affordable.

## 8. EQUIPMENT PURCHASE

The proposed purchase of equipment is: 1 – extremely poorly justified; 2 – poorly justified; 3 – justified; 4 – well justified; or 5 – extremely well justified. (Circle 5 if no equipment is to be purchased.)

### **Reviewer 13-10 (Rating: 5)**

*(NOTE: Reviewer 13-10 provided no comments.)*

### **Reviewer 13-11 (Rating: 5)**

No equipment is planned to be purchased with NDIC funds.

### **Reviewer 13-12 (Rating: 5)**

The major equipment purchase will be covered by the UND Civil Engineering Department.

## 9. FACILITIES

The facilities and equipment available and to be purchased for the proposed research are: 1 – very inadequate; 2 – inadequate; 3 – adequate; 4 – notably good; or 5 – exceptionally good.

### **Reviewer 13-10 (Rating: 5)**

The facilities available through UND and GRE are exceptional.

**Reviewer 13-11 (Rating: 3)**

A new freeze-thaw cabinet is proposed to be purchased using UND dollars but no instrument quote is provided with the proposal. The other facilities appear adequate to perform the proposed research.

**Reviewer 13-12 (Rating: 5)**

The project will have access to excellent facilities and equipment.

10. **BUDGET**

The proposed budget "value"<sup>1</sup> relative to the outlined work and the financial commitment from other sources<sup>2</sup> is of: 1 - very low value; 2 - low value; 3 - average value; 4 - high value; or 5 very high value.

**Reviewer 13-10 (Rating: 5)**

This is a very modest request with support from GRE and UND.

**Reviewer 13-11 (Rating: 3)**

The proposed budget is requesting a small contribution from NDIC LRC and has support from GRE and UND. It is favorable that the contribution from the LRC is only 24% of the total project. It would be favorable to have additional letters of support from other ND utilities to further strengthen the proposal.

**Reviewer 13-12 (Rating: 5)**

The value of the budget is extremely high because the major facilities and equipment is in place at UND. The principal investigator is highly qualified and the project is well designed.

**OVERALL COMMENTS AND RECOMMENDATION:**

Please comment in a general way about the merits and flaws of the proposed project and make a recommendation whether or not to fund.

**Reviewer 13-10 (Rating: FUND)**

The merits of the project include:

- The technical and scientific quality of the proposal
- The proposed management plan
- The merit of the PI and support staff and facilities

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<sup>1</sup> "Value" – The value of the projected work and technical outcome for the budgeted amount of the project, based on your estimate of what the work might cost in research settings with which you are familiar.

<sup>2</sup> Financial commitment from other sources – A minimum of 50% of the total project must come from other than Industrial Commission sources to meet the program guidelines. Support greater than 50% from Industrial Commission sources should be evaluated as favorable to the application.

The flaws of the project include:

- A clear and simple explanation of the benefits of the project to ND
- The omission of a milestone chart
- A discussion of “Why ND lignite”

This modest request addresses an additional potential use of ND lignite fly ash. The outstanding nature of this proposal exceeds any of the potential flaws. It was a pleasure to evaluate this well written and documented proposal.

**Reviewer 13-11 (Rating: FUNDING MAY BE CONSIDERED)**

Funding may be considered.

**Project Strengths:**

The project may open up new avenues for fly ash use and is requesting a small amount of funding from the NDIC LRC. The overall test process is fairly straightforward and has appropriate statistical analysis of the results.

**Project Weaknesses:**

A detailed project management plan with milestones must be developed before the project can be funded. The project schedule is also vague and would benefit from a test matrix with planned completion dates. I would also like to see an economic analysis performed on a few of the best fly ash nanomaterial combinations to see if the products are economically feasible for further development and testing. The budget seems insufficient to secure the materials and supplies required for and in-depth test program.

**Reviewer 13-12 (Rating: FUND)**

The project is a great example of industry, the state of North Dakota and the University of North Dakota working together to benefit the lignite, transportation and building industries while at the same time reducing waste a landfills, reducing energy consumption and air pollution. It is an excellent project and I would recommend it be funded.