TALK ABOUT POLLUTION
WITH A SOLUTION

STUDIES ON FAILURE OF STRUCTURAL CONCRETE IN NUCLEAR POWER PLANTS

-International Scientific Fraternity-

Studies on failure of concrete in structures of Nuclear plants by:

- *University of California, Los Angels, USA. 2016.*
- *Oak Ridge National Laboratory, Tennessee, USA. 2018.*
- *The University of Tokyo, Japan, 2024.*

Studies at all the above Institutes established that, due to impact of radiation, crystalline α-quartz of aggregates in concrete transforms into amorphous state, leading to volume expansion and deterioration of concrete.

Studies by University of Tokyo (UoT) for simulating the conversion of crystalline constituents of concrete in nuclear reactors to amorphous state:

To simulate the phenomenon, Metachert, a form of quartz with 92% purity of silica, was subjected for irradiation in the JEEP II reactor at the Norway's Institute for Energy Technology (IEF), the heavy water reactor, at a temperature monitored at around 53.3 ^{o}C. But it took about 2 years due to limitations of reactor.

The resultant product was studied under Raman Spectroscopy and X-Ray Diffraction (XRD) whereby the changes from crystalline to amorphous state were reconfirmed .

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Irradiation of Minerals & Mineralised (Crystalline) Byproducts To produce Complementary Cement Materials (CCMs):

The Sustainable Opportunity to the World in the service of future generations

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Serendipity:

The studies of irradiation, established to prove the adverse impact on set-concrete, have been availed by the Scientists, *Dr Bhanumathidas and N Kalidas,* to tap its positive contribution in advanced concrete technology:

During their studies over last 35 years for enhancing the durability of concrete, the Scientists have established that amorphous products do perform as Complementary Cement Materials (CCMs). They extended their knowledge to various structures, including the critical structure like 'shatter-proof concrete hangars' for parking bomber flights (in India).

Difference between crystalline and amorphous structures:

Crystalline products are non-reactive, with exceptions; hence cannot be blended with cement.

Amorphous products are reactive with lime or ‘lime leached out of cement’. Ordinary Portland Cement (OPC) does release over 25% surplus lime upon hydration (akin to surplus sugar to human body) effecting the durability of concrete. This lime needs to be engaged with amorphous products such as complementary cement materials (CCMs) for mitigating its deleterious impact, as well enhancing the strength, micro-structure and overall durability of concrete.

COMPLEMENTARY CEMENT MATERIALS (CCM)
Which perform like cement while associated with OPC/Lime

PRODUCT	STRUCTURE	STATUS	SOURCE
Silica fume	Amorphous	Totally Reactive	Byproduct of ferro-silicon industries
Metakaolin	Amorphous	Majorly reactive	Crystalline clay transformed to amorphous state at high temperature (at around 800 ^{o}C)
Fly ash	Majorly crystalline; moderately amorphous.	Majorly non-reactive; moderately reactive.	Clay content of coal is transformed into ash while burnt in furnaces of thermal plants.
Rice Husk ash (RHA)	Crystalline	Non-reactive	Rice husk based boilers and power plants.

Some of the World famous reference structures with CCMs in concrete:

Structure	Silica fume	Fly ash
Petronas Towers, Malaysia	6.3%	37.5%
Akashi Kaikyo Bridge, Japan	yes	20%
Three Gorges Dam, China	yes	30-40%
Euro Tunnel, UK-France	yes	30-40%

Economic spin off at National level (India):

Component	Rate/Unit	Impact: USD Billion
Investment of Irradiation plant with nuclear reactor	@ US$ 1.0 billion/plant; 50 plants	50
Doubling the cement capacity With 50% blend; capital savings	@ US$ 1.0 billion/plant- US$ 0.015 for grinding = 0.985 bn*600 plants	591
CO_2 credit on Amorphized ash of 2860 mn.t @ 0.84 t CO_2 = 2402 mn.t	@ $ 5/t CO_2	12

Economic spin off at National level (India):

Component	Rate/Unit	Impact: Rs. Billion
By amorphous silica (akin to silica fume)	0.39 bn/ t @ US$ 400/ ton	156.0
By amorphous Fly ash out of ash ponds	As CCM: 2860 mn.t @USD 47.06/t	134.6
By Rice Husk Ash (RHA) (8.5 mn.t*50%*20%*20%)	10% of 137 mn.tpa of paddy tapped 0.548 mn.t of RHA @ US$400/t	0.22
By retrieving land occupied by ash ponds	26000 Ha @ USD 0.88 mn/Ha	22.88

SD GOALS SERVED BY THIS PROJECT

- Conservation of mineral wealth
- Utilization of industrial byproducts
- Conservation of coal
- Abatement of CO_2 by avoiding fossil fuel
- Abatement of CO_2 by doubling the capacity of cement plants without producing additional clinker.
- Prolonging the longevity of concrete at least by 3 to 4 times, thus leading to conserve mineral wealth.

Proposed Action Plan:
(Trial Production)

It is necessary to irradiate 10 tons of each sample (mineral quartz, fly ash, rice husk ash) to amorphous state in the least possible duration by locating suitable reactor anywhere in the World that has:

Neutron fluence level: 1.43×10^{20} n/cm^2

Neutron flux : 3×10^{12} n/cm^2/s

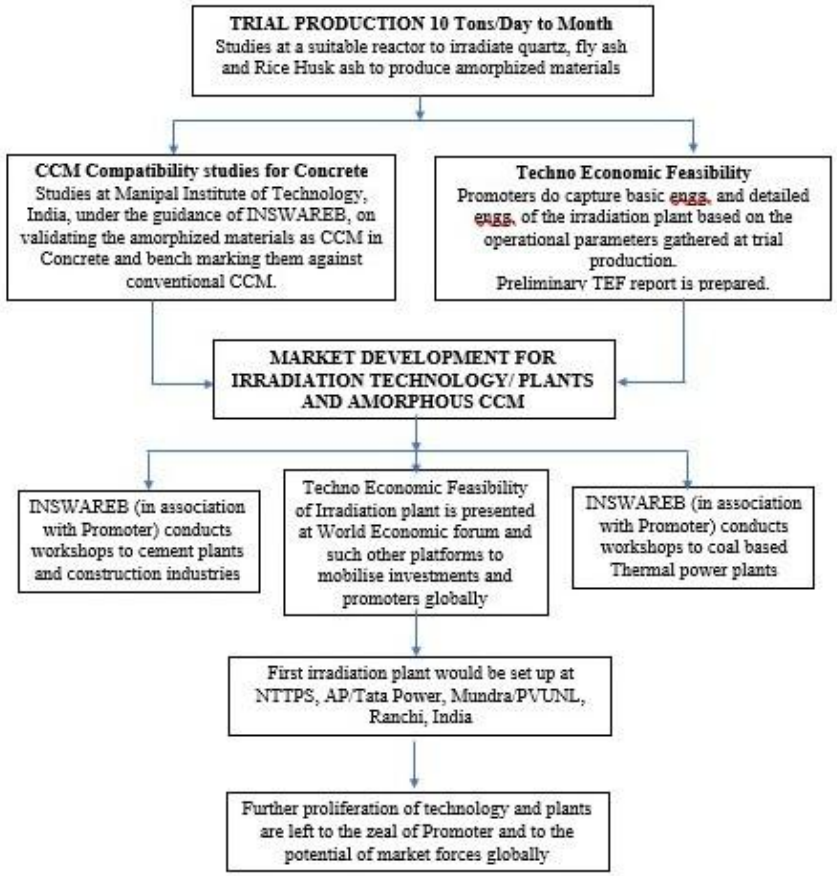
There after, develop concrete blended with irradiated samples; conduct strength and durability studies to benchmark them as against conventional CCMs.

Proposed Action Plan:
(Techno-Economic Feasibility study)

Based on trial production, capture the data for basic and detailed engg. for commercial plant; prepare the techno-economic feasibility report.

There upon unveil the project to investors at World Economic Forum and such other economic platforms, to invite promoters for setting up the plants. India could be the best bet with over 150 coal based thermal plants; 2.86 billion tons of fly ash in ash ponds occupying over 26,000 hectares of land.

CONCEPTUAL CHART FOR THE IMPLEMENTATION OF IRRADIATION PROJECT FOR THE PRODUCTION OF AMORPHISED COMPLEMENTARY CEMENT MATERIALS (CCM) OUT OF MINERALS AND MINERALISED INDUSTRIAL BYPRODUCTS



Distinction of this project

Scientists have proved their mettle in developing FaL-G, Nano Concrete, and 'Carbon credits for micro industries', as first of their kind in the world plateau.

Irradiation of crystalline minerals and byproducts is another fete, conceived for the first time in the World. Whichever country takes the lead to make this project a reality proves its edge at international level, notwithstanding the economic spin off bestowed to green economy.

“Creation is embedded with every solution that Science can unravel in the welfare of Mankind, despite the Universe getting exploited unmindful of Security of the Human Race”.

- Dr N Bhanumathidas & N Kalidas -

Irradiation of minerals and Byproducts is one such Solution in the service of future generations. Let us tap this segment to its full potential.

IRRADIATION-INDUSTRIES facilitate Massive Global Investments clubbed with Sustainable Marketing Opportunities.

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We appeal to all UN Bodies, Heads of Countries, Industrial Houses & Investment-Corporates, all over the World, to make this project a reality in the service of Sustainable Development and Green Economy.

-Dr N Bhanumathidas & N Kalidas-