Short Communication

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Success of Underground Grain Storage Structures- Indian Perspective

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After continuous struggle, India got freedom from hunger through the Green Revolution which began in 1960s during which agriculture in India was converted into a modern industrial system by the adoption of technology, such as the use of high yielding variety (HYV) seeds, mechanized farm tools, irrigation facilities, pesticides, and fertilizers. Agricultural research and technology to increase agricultural productivity in India (Wikipedia). Varieties or strains of crops can be selected by breeding for various useful characteristics such as disease resistance, response to fertilizers, product quality and high yields. Despite all this no proper grain storage facility was developed by India which guarantee through supply of grains to its citizens in a very efficient way. India's public distribution is a big failure, which is continuously dominated by their caste politics and box philosophy. The ancient Romans agricultural practices included the cultivation of grains, olives, and grapes. The storage pits were also used to store grain in underground pits these were airtight repositories for the storage of grain. Although underground storage is not very uncommon, a case study located in the Western Dolomites (Val Di Non, Trento, Italy), (Fig 1), the storage space is for food, groundwater and a data hosting center. After the extraction of the dolomitic rock used in construction, underground excavated spaces are storage for food grain. And its inner surfaces have been protected by a gas-proof mineral hydraulic lime material. This material applied to the lateral walls and to the ceiling for stabilization of the superficial cave rock mass and to prevent the infiltration of humidity and gases through the cell's walls [10].

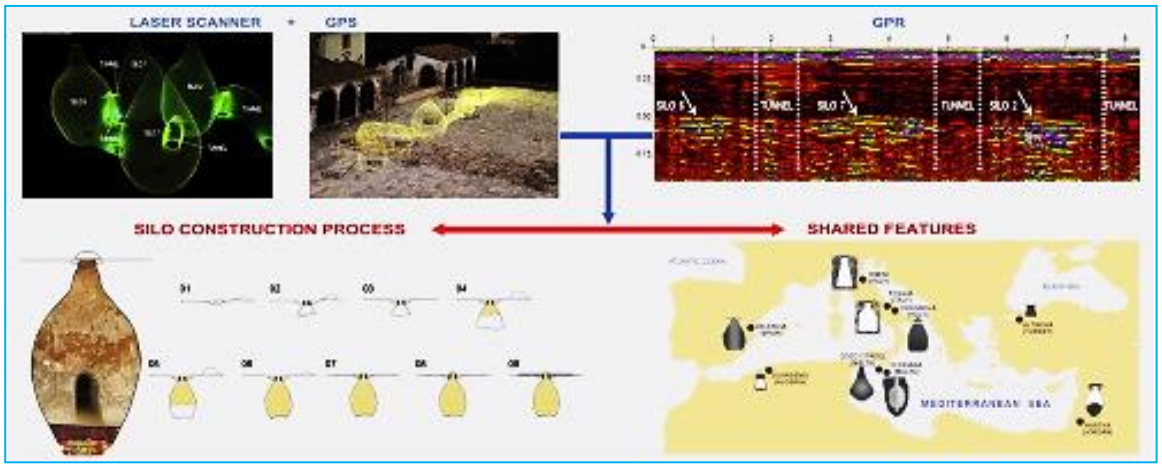

Fig 1 Ancient underground storage systems

In ancient times, these subterranean granaries were excavated on the top of a small flat hill. It is because to save grains from extreme weather conditions like rainwater accumulation. This can be achieved by the because its elevated position allowed the excavation of underground structures without reaching groundwater table. In India Grains were stored in Silos. They were dug in a clayey soil because of nodules of carbonates and intercalations of limestone crust substrates. They were suitable terrain for underground grain storage facilities. The main advantage is the easiness of excavation, the consistency and the hydrothermal conditions for wheat preservation. This enables them to prevent from infestation due to key biological factors such as low oxygen atmosphere, uniform low temperature and low moisture content. This makes the appropriate choice for underground grain storage [2].

The success of underground grain storage influences by the modern disaster such as the nuclear radiation accidents on agriculture may in the form of nuclear power reactor accidents.

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India needs to ascertain its nuclear radiation risks in proper perspective with other risks. And formulate the plan of action for the agricultural industry if existing measures insufficient [3].

In preservation and storage of grains fundamental difference lies in the objective and purpose, preservation of grains means preservation of same structural, physical and engineering properties of the grains at the time of filling. Whereas Storage of grains means not responsible for preservation of engineering and physical properties of the grains during and after the storage processes. Now days, following requirements of storage are listed:

- Maintaining the same temperature throughout the year.
- Strictly controlling the indoor atmospheric composition and parameters (Controlled Atmosphere, CA).
- Avoiding the penetration of humidity and gases into the rock mass may be by protective layers of grouts.

Technique used in underground grain storage facility

The warehouse cooling system starts lowering the temperature of the underground space close to 1 °C before the grains are deposited; second, once this underground space facility has been completely stocked with the grain bins, it is hermetically closed and the oxygen inside is substituted with a gas mixture mainly composed of nitrogen (98%), in order to reach Controlled Atmosphere conditions according to the Ultra-Low Oxygen (ULO) methodology [4]. The oxygen and dioxide contents are therefore maintained at 2% and 2–3% respectively. The internal humidity will be controlled by the geological features of the formation and to the proper grouting materials applied on the inner surfaces.

Most of the underground grain Storage structures depend on mechanical ventilation system for achieving an acceptable indoor thermal comfort level. To in cooperate the greenhouse effect, it is essential to incorporate a active system in an underground grain storage to reduce the overall building energy consumption. For this proper hermatic storage condition needs to be designed as per the stored grain and existing geologic conditions. A indices needs to be devised say the Indoor Environmental Quality index (IEQ) to measure the effectiveness of the underground ventilation system. This may be solved with the modern tools like artificial intelligence to integrate the design procedure that combines both underground building simulation and design optimization methods. The review of this topic, however, is rather scarce in the open literature. Concept of underground ventilation system, presents the IEQ level assessments reports by users which is the critical element in optimization and active design strategy in the underground grain storage. The Farmers needs to be encouraged using the existing soil and natural ventilation to effectively reduce the energy consumption in underground conditioning system. Natural ventilation is the process of supplying fresh air into the underground space and removing moist indoor air from the underground space with the help of wind pressure, thermal buoyancy or a combination of both. Natural ventilation systems will reduce up to 25% of energy consumption. The excess concentration of bio effluents with CO_2 could be removed by employing a well-designed ventilation system [5]. A good ventilation system ensures proper circulation of fresh air inside the underground space and maintains the desired humidity level.

By the application of geothermal piles and geothermal energy coupled with optimal insulation is one of the best approaches in maximizing the energy saving for an underground storage system during heating and cooling operations [6-7].

Underground Storage systems are infamous for to contain a collection of living organisms. To preserve the quality of the grain it must be alive but dormant. The pest —such as insects, mites and fungi—in the grain needs to be contained. Underground sealed structures to preserve grain quality are found in underground grain and bean storage sites in the U.S., Argentina, North Africa, and East Central Africa [2]. Recently developed Artificial Intelligence computer programs, such as for 3-D heat and mass transfer in stored grain in designing the underground structure.

SUMMARY

The lukewarm reactions from the authorities in India are the major cause for non-popularization of underground grain storage structures. As per the UNSC 9386th meeting, attack on Odesa port grain facility highlighted the need of underground food grain storage facility which will be safe from biological, chemical and nuclear weapons. The difficulty in making earthen underground grain silos is very less as compared to metal bins. Earthen underground silos require only rammed earth, rice or wheat husk and 2 to 3 meter pit. But difficulty lies in the pest infestation, regulation of moisture and air flow inside the earth. With advancement in Geotechnical and Rock Engineering, a very low-cost underground grain storage structure is feasible in any part of India based on geological and environmental consideration. Latest underground construction techniques also provide solid foundation for low-cost grain storage structure at farm level, a better alternative to Cover and Plinth storage (CAP).

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