SELF HEALING CONCRETE

Made & Presented By:- Amitoj Singh
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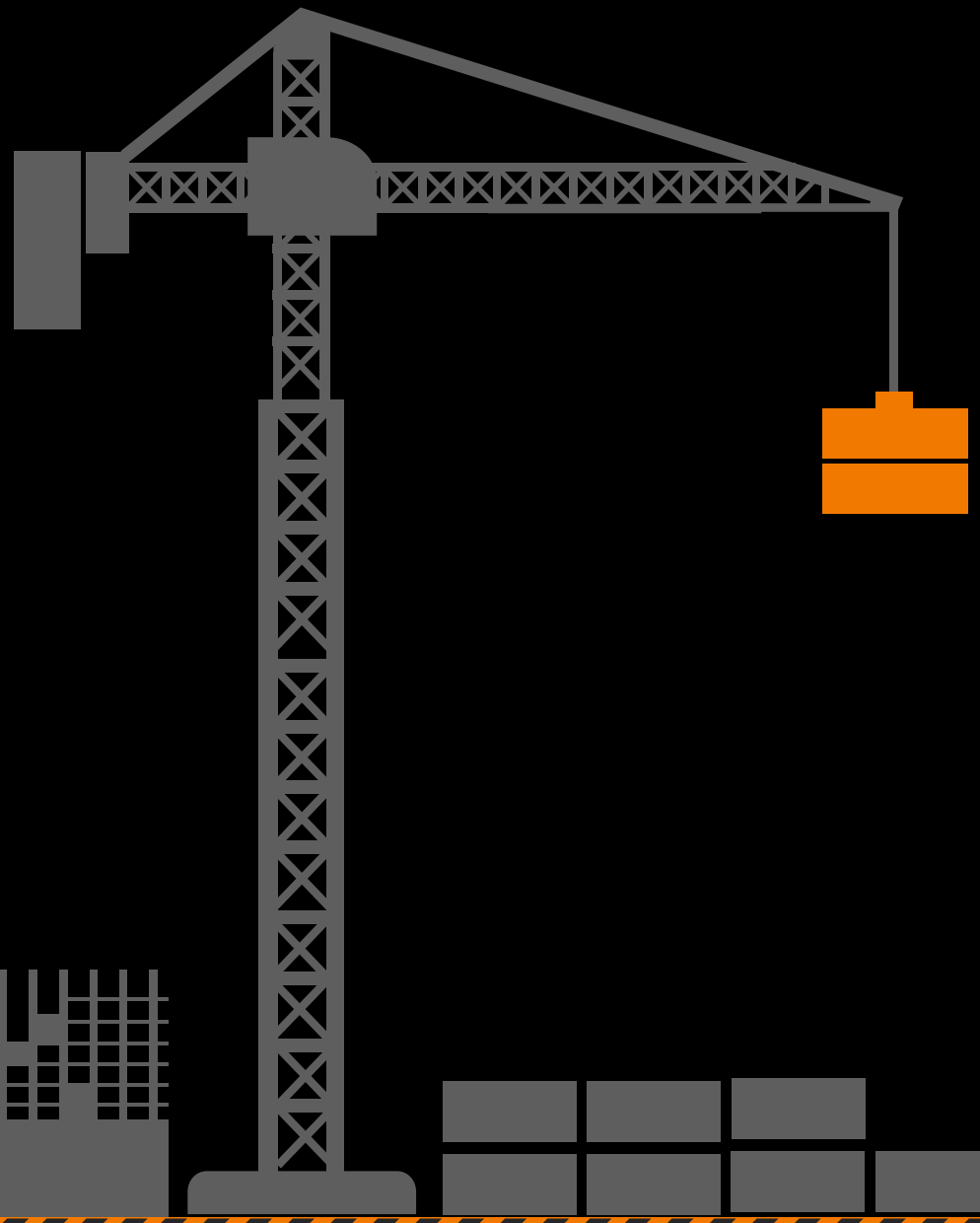
Submitted to:- Prof. Yuvraj Singh

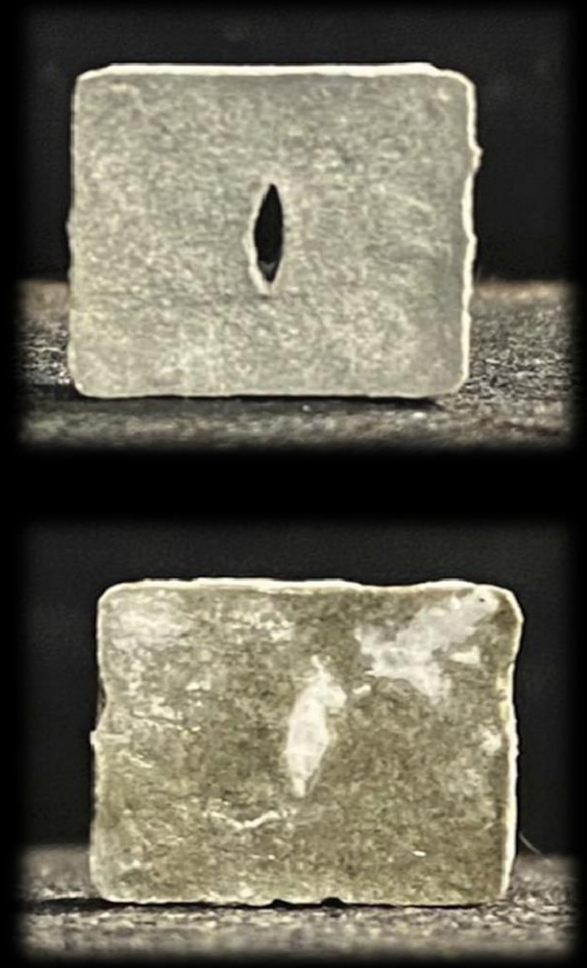


CONTENT :-

Introduction

INTRODUCTION:

- Crack formation is a typical phenomenon related to durability. Percolation of cracks may lead to leakage problems, causing deterioration of the concrete matrix or corrosion of embedded steel reinforcement.
- In recent years a bacteria based self healing concrete is being developed in order to extend the service life. A two component healing agent is added to the concrete mixture.
- Self healing concrete is a concrete which heals itself when it comes in contact with air and water, it produces lime on outer layer of concrete.
- In most of traditional concrete mixtures 20-30% of cement is left unhydrated, the presence of a large amount of unhydrated cement should result in excellent autogenous self-healing.
- If cracking of concrete occurs, unreacted cement grains may become exposed to moisture penetrating cracks. In that case the hydration process may start again and hydration products may fill up and heal up.



WHAT IS SELF HEALING CONCRETE?

- It is a special type of concrete invented by a group of microbiology researchers under the head of Hendrik Marius Jonkers, a Netherland based microbiologist.
- Self-healing concrete is mostly defined as the ability of concrete to repair its cracks autogenously or autonomously. It is also called self-repairing concrete. Cracks in concrete are a common phenomenon due to its relatively low tensile strength.
- Self Healing concrete is also known as "BIO CONCRETE" or "BACTERIAL CONCRETE".
- It is specially made to increase the life span and durability of concrete structure by self healing action of that concrete.

Necessity

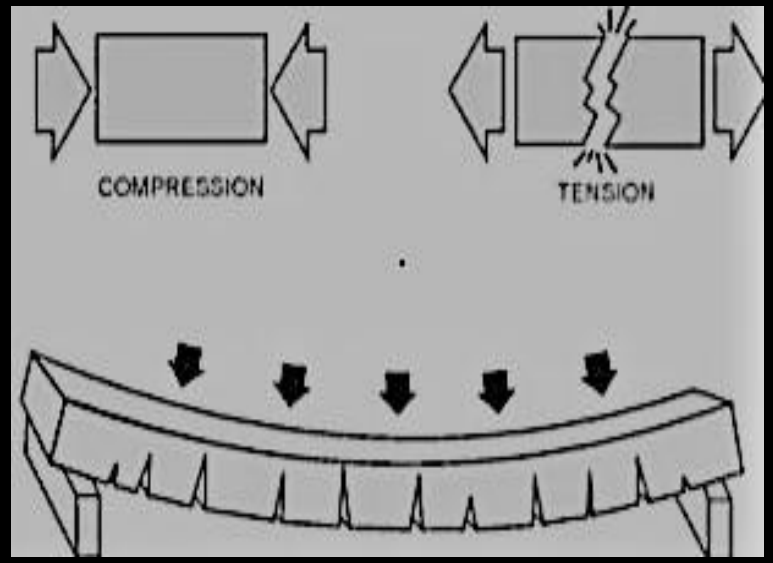
NECESSITY

The need for Self-Healing concrete:

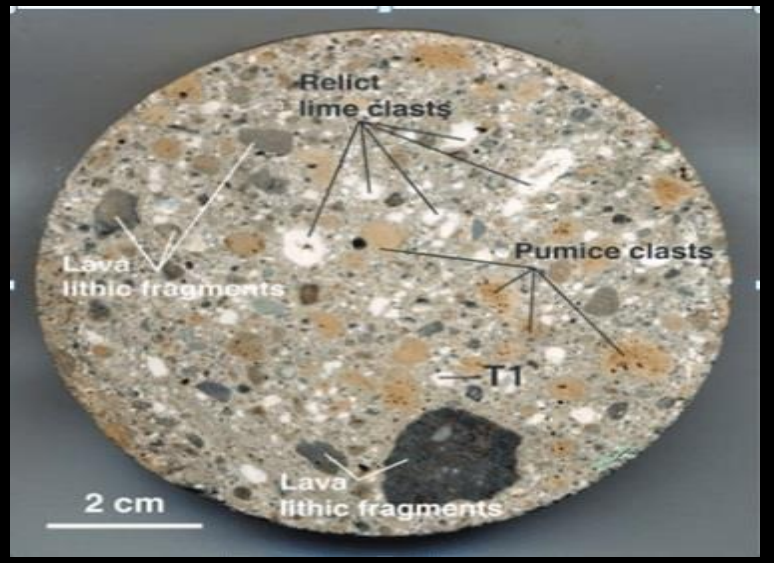
Cracks allow water to seeps and it will deteriorate the concrete and corrode the steel reinforcement. It will finally reduce the lifespan of the building. Self-healing concrete is a product that will biologically produce limestone to heal the cracks. Some more reasons for which we require self healing concrete:

1. Forces on Concrete
2. Concrete with reinforcement
3. Lime filled in concrete

NECESSITY



Due to forces on Concrete



Lime filled in concrete

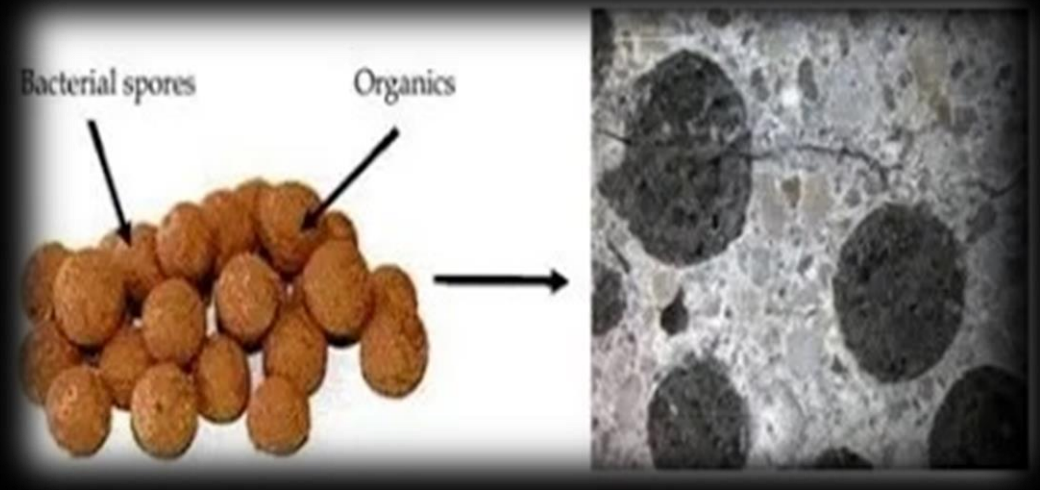
Concrete with reinforcement


Working

MIXING

To create self-healing concrete, some special materials (such as fibers or capsules), which contain some adhesive liquids, are dispensed into the concrete mix. When cracks happen, the fibers or capsules will break and the liquid contained in them will then heal the crack at once.

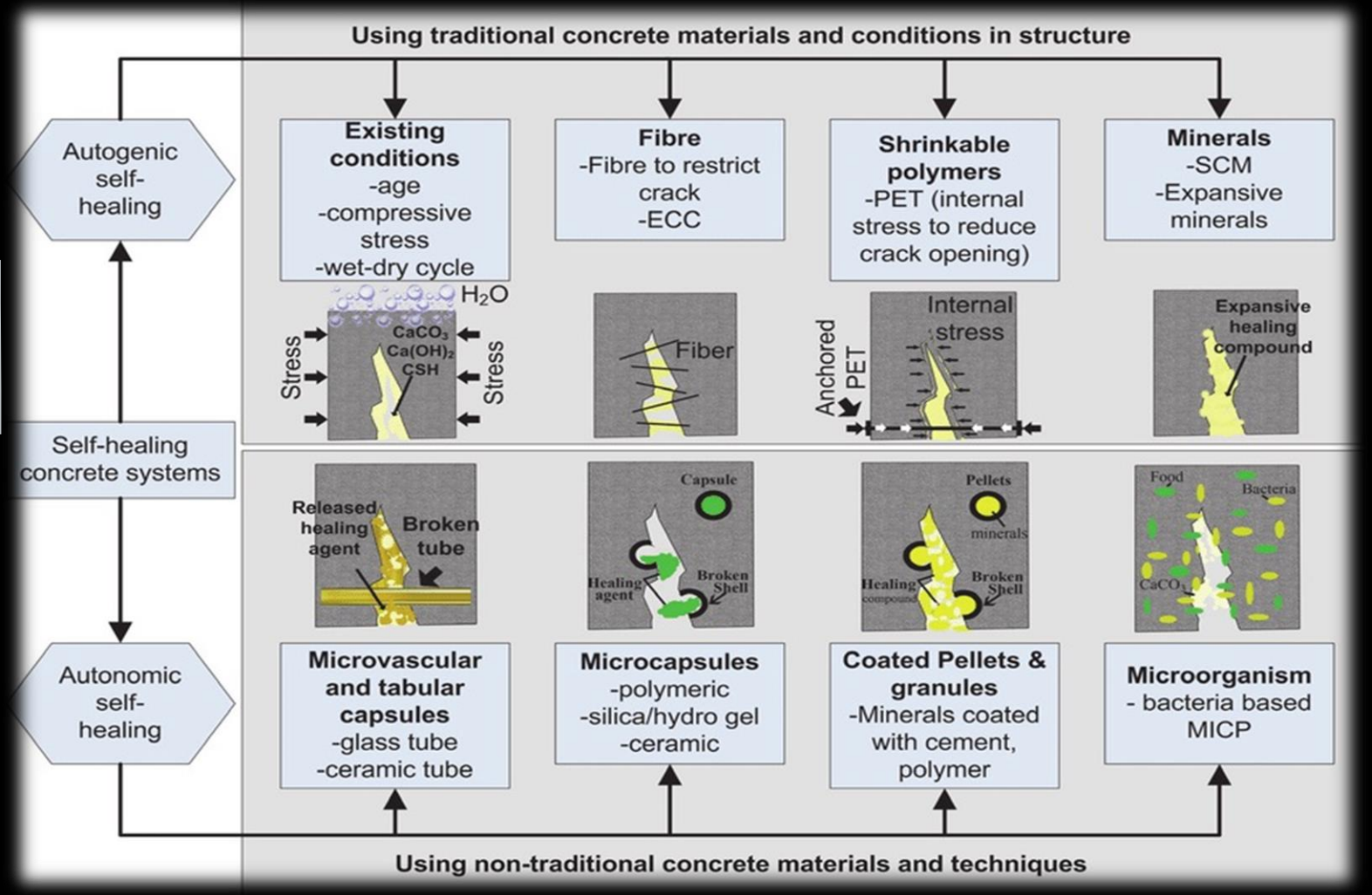
When spores(certain fungi, plants, ferns and bacteria produce, spores are involved in reproduction adapted for dispersal and for survival) fine aggregate, coarse aggregate and content are mixed together which results in Self healing concrete



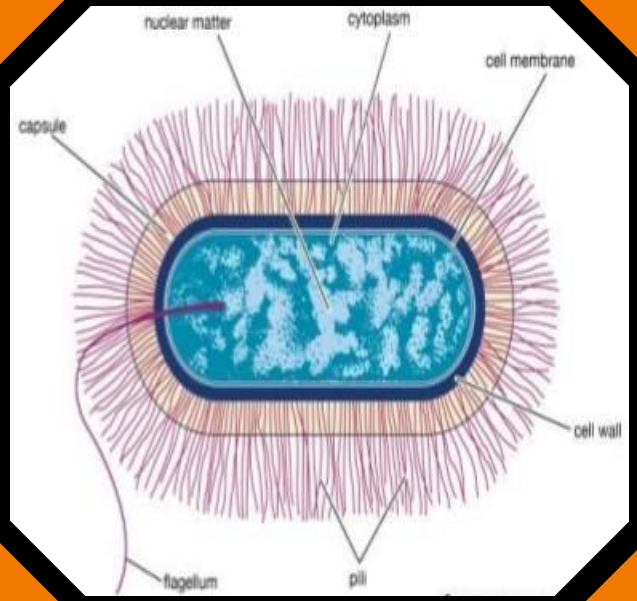
But while mixing one precaution is taken that bacteria and cement are not allowed to mix together with the help of clay pallets.

While preparation of concrete, this product is added in the wet concrete when the mixing is done

TYPES OF SELF HEALING CONCRETE SYSTEMS



BACTERIA USED IN SELF HEALING CONCRETE



It contains an outer layer of thick wall, which resist sunlight, chemical exposure etc.
In 1877, Ferdinand Cohn claimed that with a bacteria known as “Genus Bacillus” Concrete could be healed.

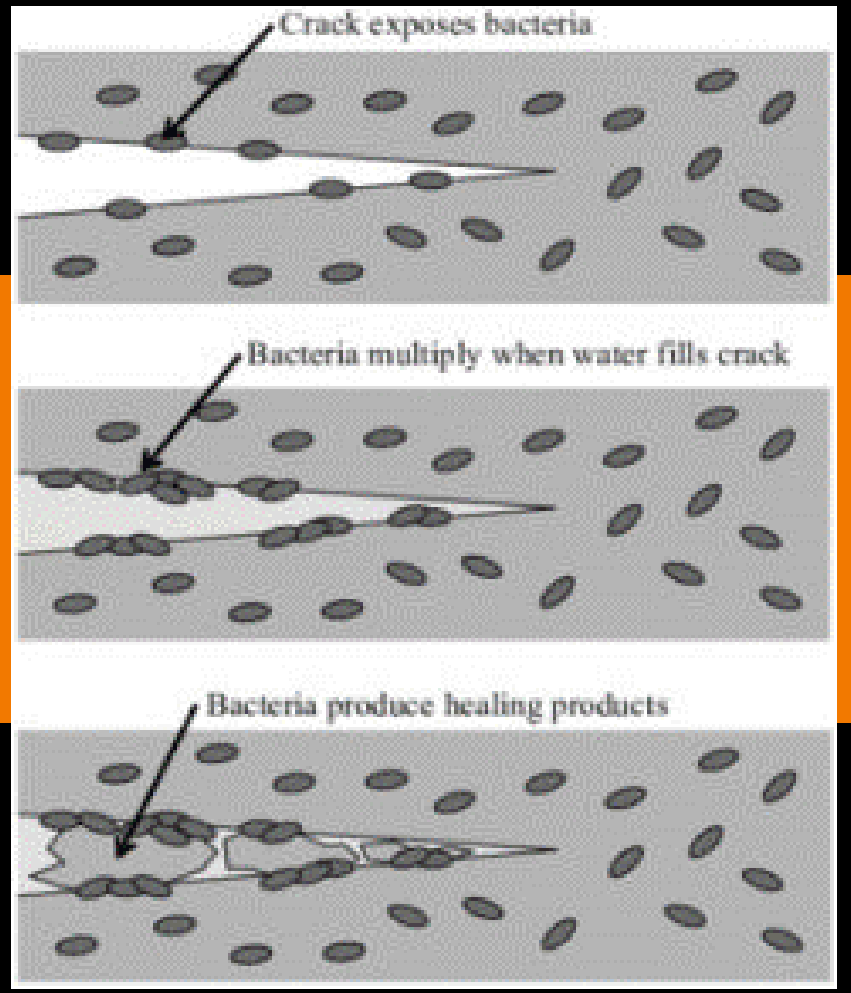
Most of the bacteria belongs to genus bacillus are fulfilling required criteria discussed, some of the list of bacteria are:

- Pseudofirmus
- Cohnii
- Filla
- Pasteurii

➢ The suitable chemical precursor found to be most suitable is “Calcium Lactate”.

The width of range 0.05-0.1mm act as capillary and the water particles seep through the cracks. These water particles hydrate the non or partially reacted cement and the cement expands, which in turn fills the crack.

But when the cracks are of greater width, need of other remedial work is required. One possible technique is currently being investigated and developed was based on application of mineral producing bacteria in concrete.



WORKING OF SELF HEALING CONCRETE

Self healing concrete is a product that will biologically produce limestone to heal cracks that appear on the surface of concrete structures.

$$Ca(C_3H_5O_2)_2 + 7O_2 \text{ ----} > CaCO_3 + 5O_2 + 5H_2O$$

(Calcium Lactate) (Lime)

Specially selected types of bacteria genus bacillus along with a calcium based nutrients known as calcium lactate, and nitrogen and phosphorus, are added to the ingredients of the concrete when it is being mixed.

WHAT HAPPENS INSIDE SHC CONCRETE

The cracks are formed on the surface of concrete due to many reasons like shrinkage, inadequate water for hydration, etc.

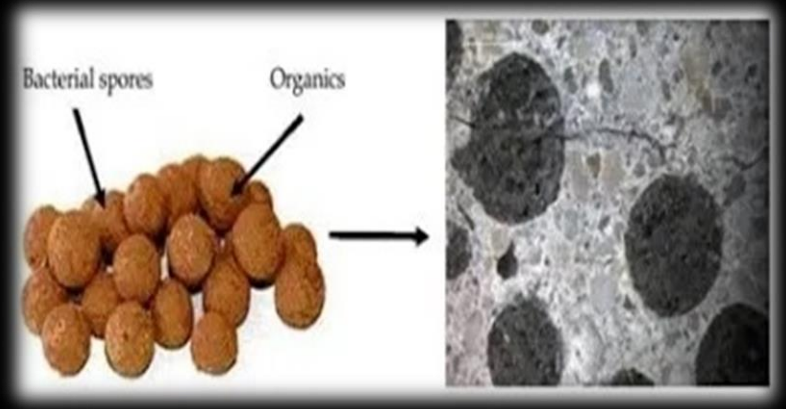
The water is deliberately forced into the cracks and the precursor is activated

The activated precursor intrim induces the bacteria to react with the precursor

Then it forms a base of calcium carbonate called as limestone

Then cracks are filled up.

HOW HEALING AGENTS ARE APPLIED?

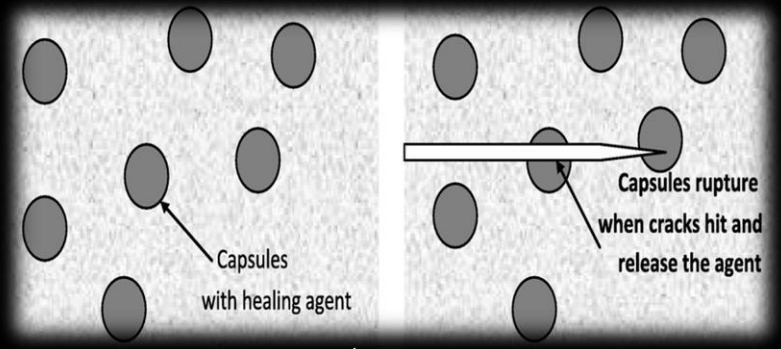


By Direct Application

- In the direct application method, bacterial spores and calcium lactate is added into concrete directly when mixing of concrete is done. The use of this bacteria and calcium lactate doesn't change the normal properties of concrete.
- The bacteria are exposed to climatic changes. When water comes in contact with this bacteria, they germinate(grow) and feed on calcium lactate and produces limestone. Thus sealing the cracks.

Method 1

Method 2



Encapsulation LWA

By encapsulation method, the bacteria and its food i.e. Calcium lactate, are placed inside treated clay pellets and concrete is prepared. About 6% by weight mix the clay pellets are added for making bacterial concrete.

When concrete structures are made with bacterial concrete, when the crack occurs in the structure and clay pellets are broken and the bacteria germinate and eat down the calcium lactate and produce limestone, which hardens and thus sealing the crack.

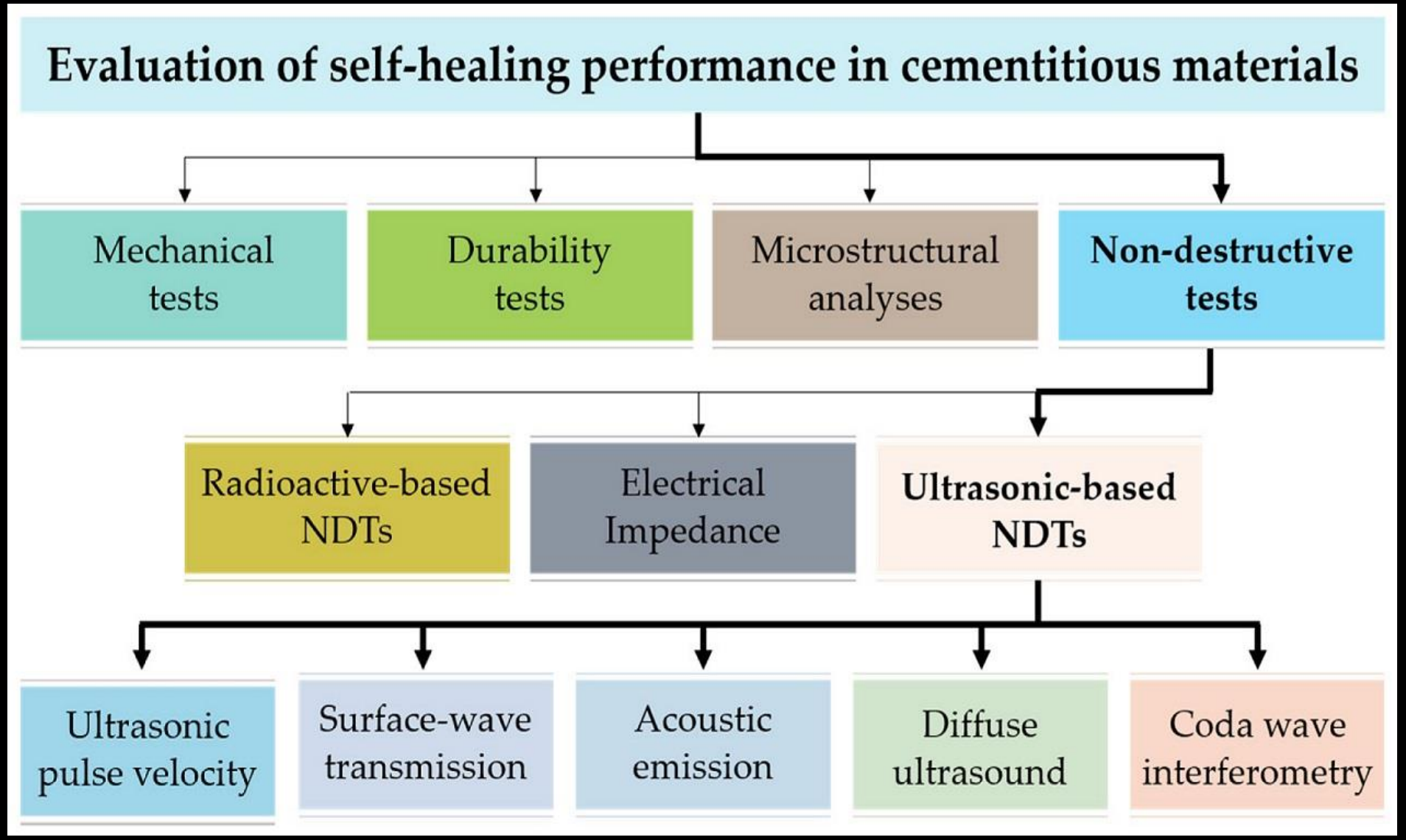
Minor cracks about 0.5mm width can be treated by using bacterial concrete. Chemical process of self-healing or bacterial concrete

Testing

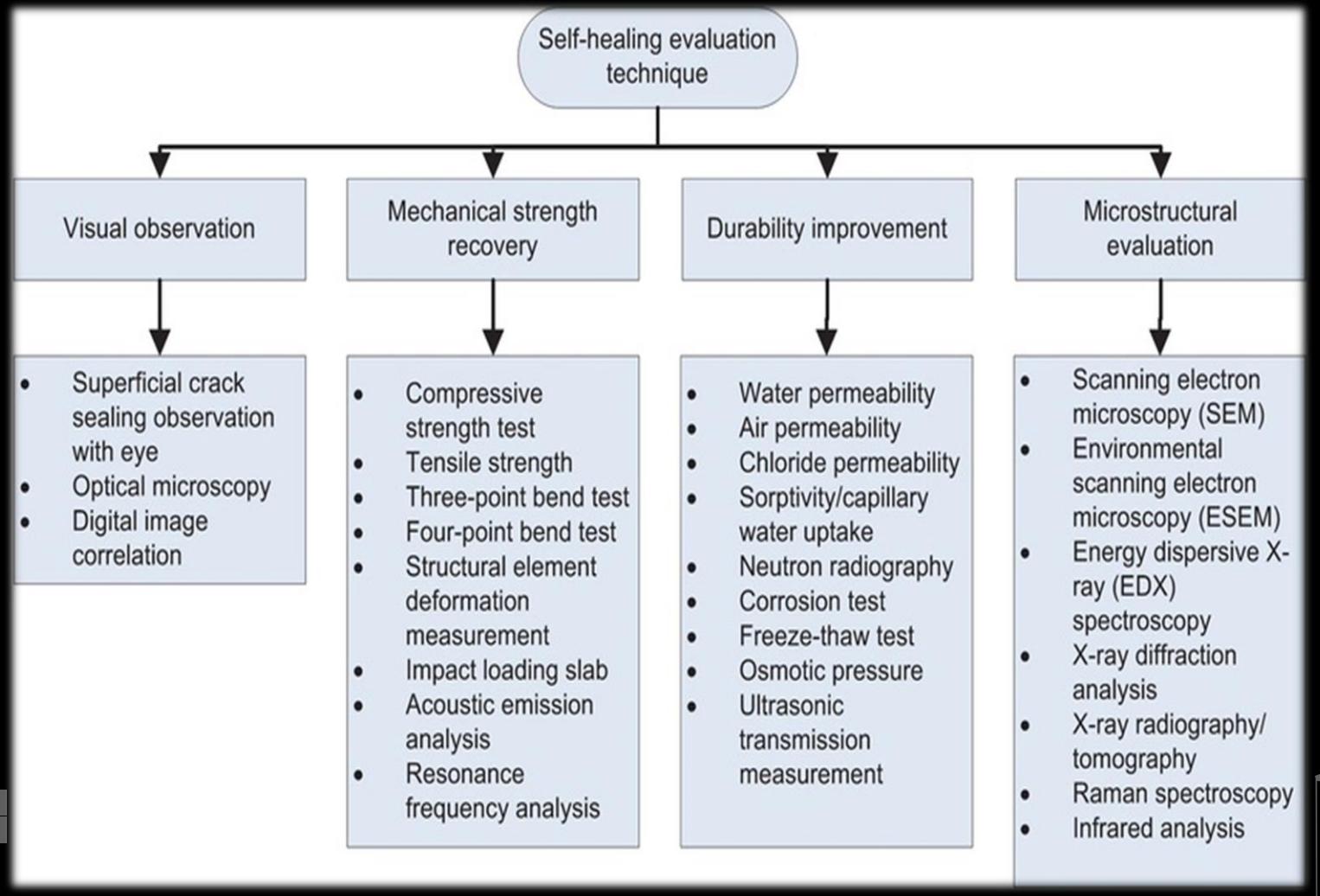
TEST ON SELF HEALING CONCRETE

- In 2011, Jonkers and his team member performed testing and prepared a case study on self healing concrete.
- Self-healing admixtures used are supplementary cementing materials, polymers and microorganisms.
- A small structure or a part of a structure will be built with the self healing material and structure will be fitted with some panels of self healing concrete and other with conventional concrete so that the behaviour of both the concrete can be compared, observed over three years to five years.
- Cracks will be made in the concrete that are much larger than the ones that have healed up in the laboratory to determine how well and fast they healed over time.
- Tests at microstructure level are commonly performed to maximize the reliability of the results.
- Self-healing to successful sealing of the crack width is the key issue.
- Visual observation (microscope, digital imaging and camera photographs) are the primary techniques.

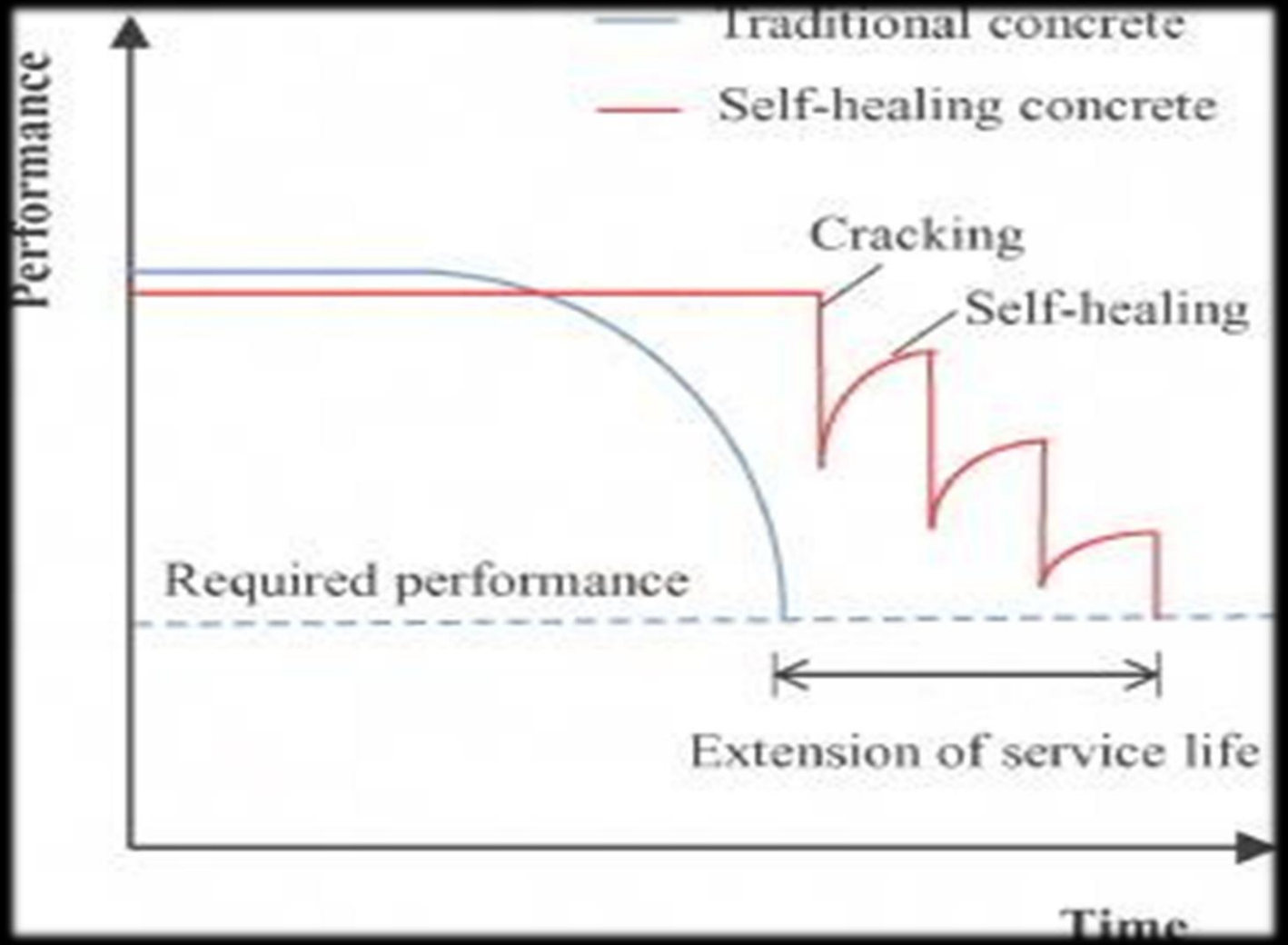
PERFORMANCE EVALUATION TESTING



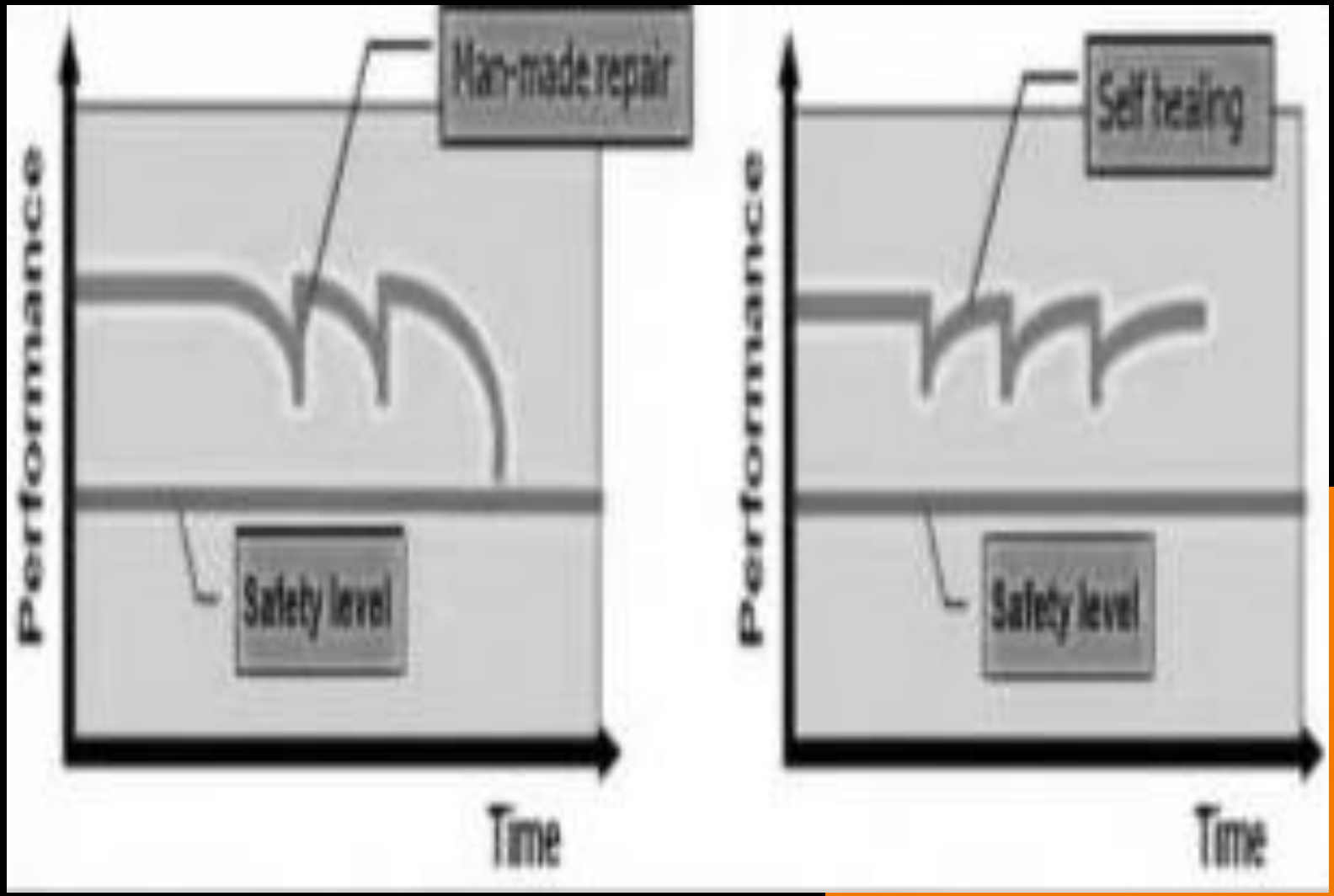
PERFORMANCE EVALUATION TECHNIQUES



PERFORMANCE VS TIME GRAPH



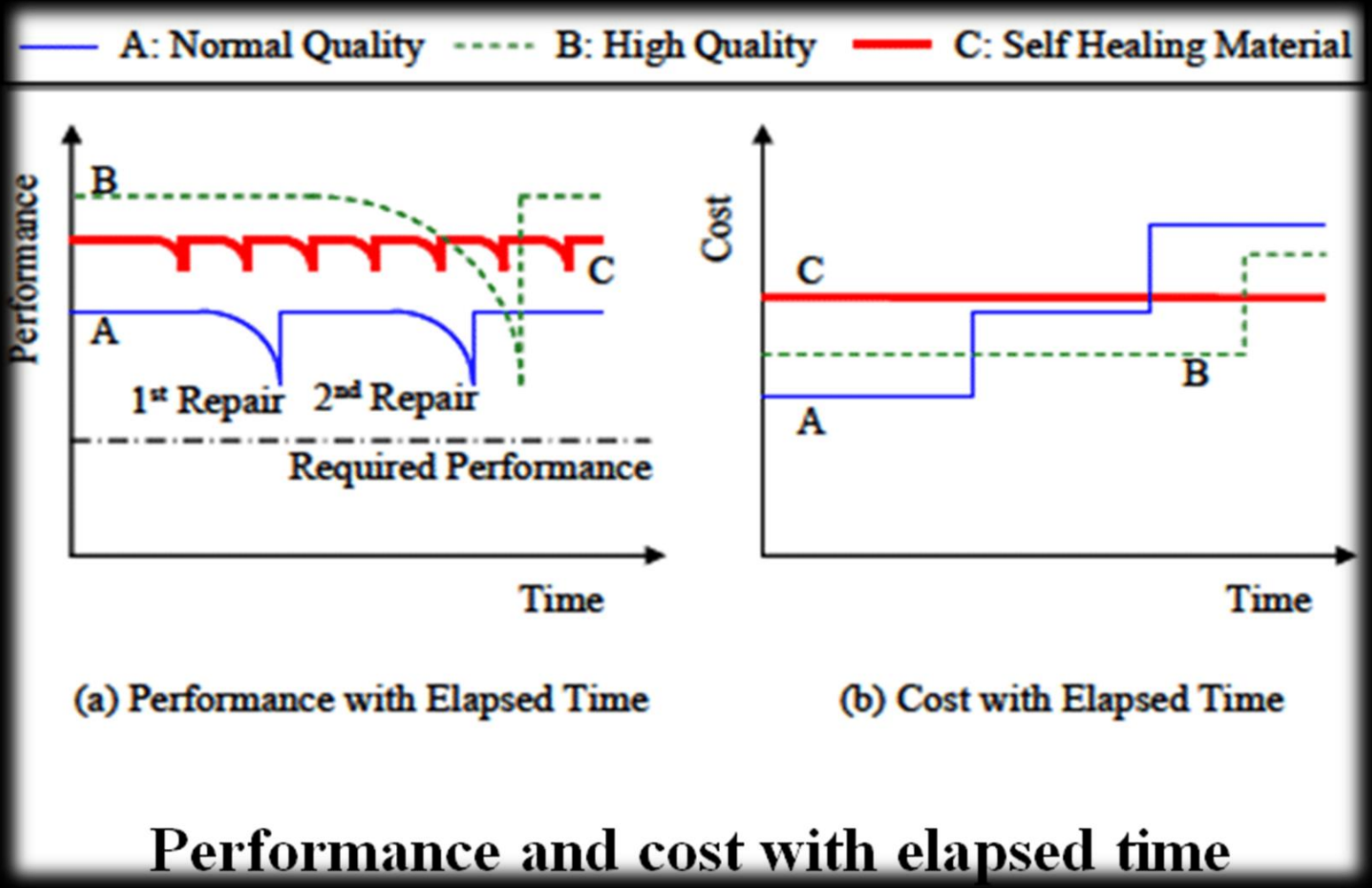
PERFORMANCE BASED COMPARISON BETWEEN SELF HEALING & MAN MADE REPAIRS



Graph of performance w.r.t. to time for both Self healing concrete and man made repair on hardened concrete.
X- axis denotes: Time
Y- axis denotes: Performance
Left graph: Man made repairs
Right graph: Self healing

Safety level is defined as a relative levels of risk-reduction provided by a safety function, or to specify a target level of risk reduction.

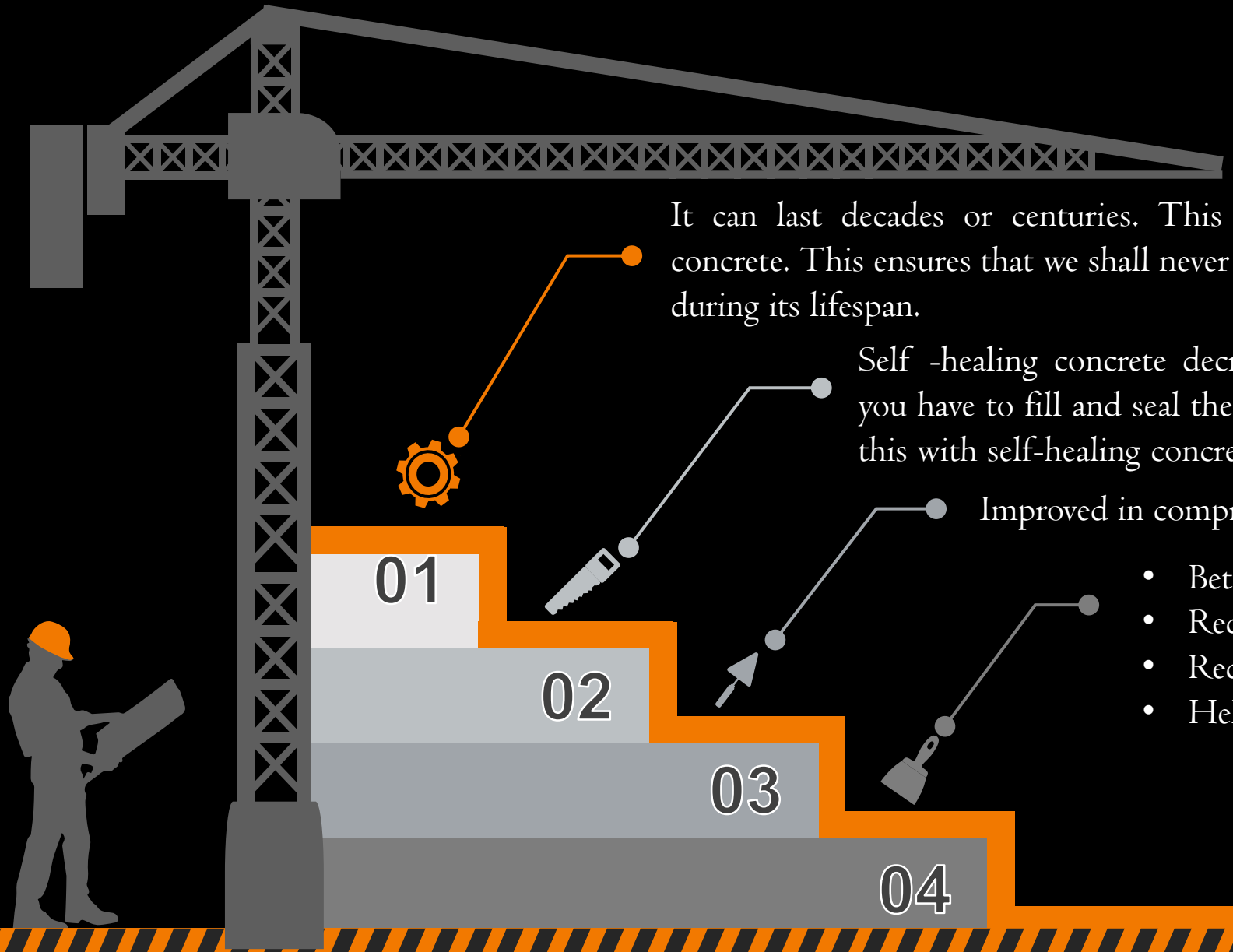
PERFORMANCE AND COST BASED COMPARISON AMONG VARIOUS TYPES OF CONCRETE ON BASIS OF THEIR QUALITY



Performance and cost with elapsed time

Advantages

ADVANTAGES



It can last decades or centuries. This is the biggest advantage of self-healing concrete. This ensures that we shall never have to replace your concrete surface again during its lifespan.

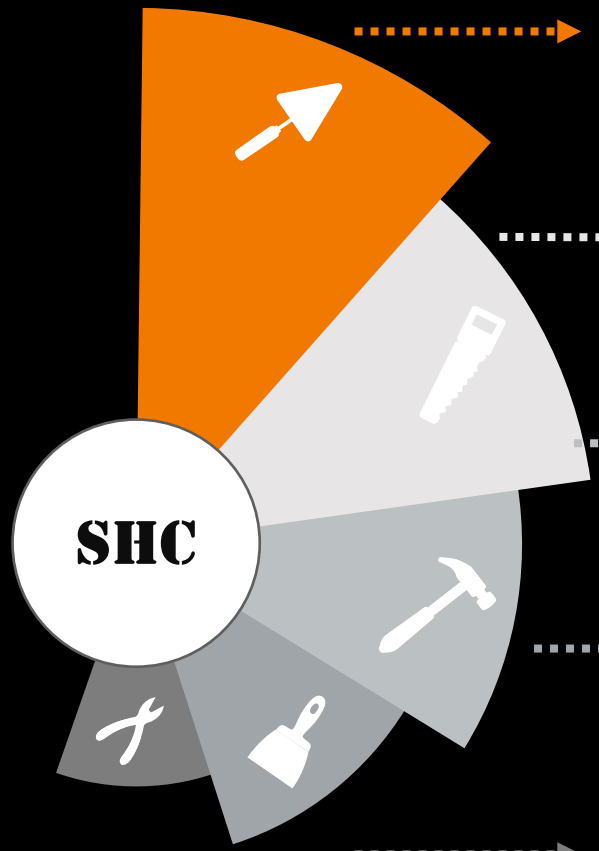
Self -healing concrete decreases concrete maintenance. In normal concrete, you have to fill and seal the cracks. But you do not have to do or worry about this with self-healing concrete

Improved in compressive strength of concrete.

- Better resistance towards freeze and thaw effect
- Reduction in permeability of Concrete
- Reduction in corrosion of reinforced concrete
- Helps to reduce maintenance and repair

Disadvantages

DISADVANTAGES



One of the biggest disadvantages currently of it is cost. It is expensive compared to normal concrete. Maybe in future, the cost will reduce when self -healing concrete will become common. Now it is quite rare

Not many contractors know how to use this product yet. Because it is a new product many people do not have an idea of using it.

There is no code available to standardize the self-healing concrete. Skilled labour is required.

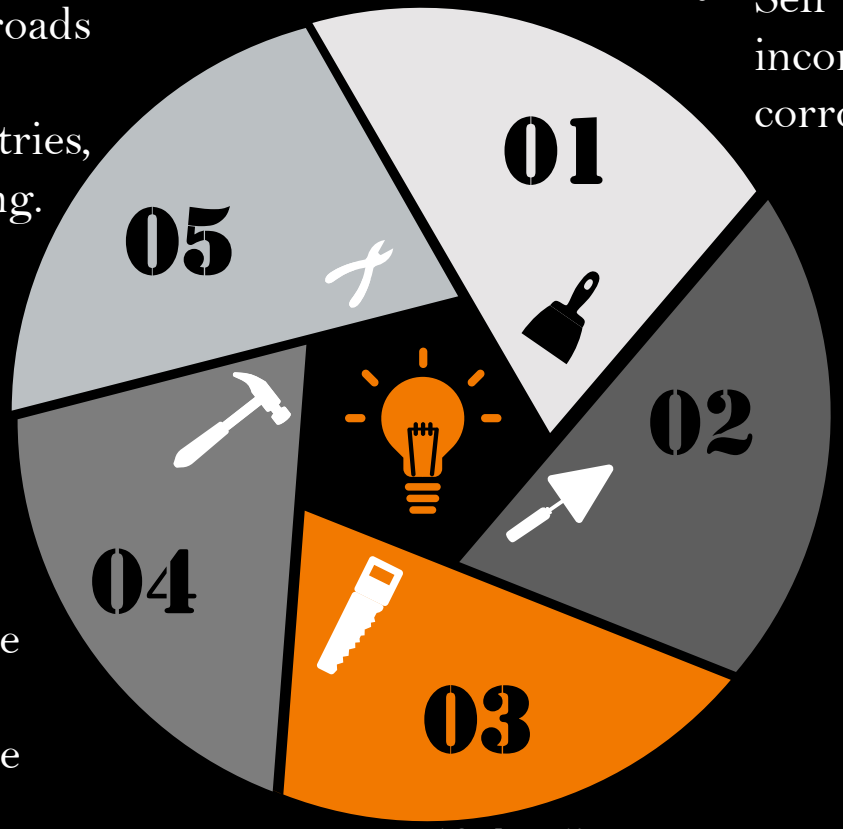
Cost of Self healing concrete is double than conventional concrete, Investigation of calcite precipitation is costly studied.

Growth of any bacteria is not good in any atmosphere.

Applications

APPLICATIONS

- It can be actively used in the case of roads to reduce traffic jams.
- Also used by the oil and gas industries, preventing small cracks from spreading.



- Self Healing concrete epoxies can be incorporated on the metals to prevent corrosion.

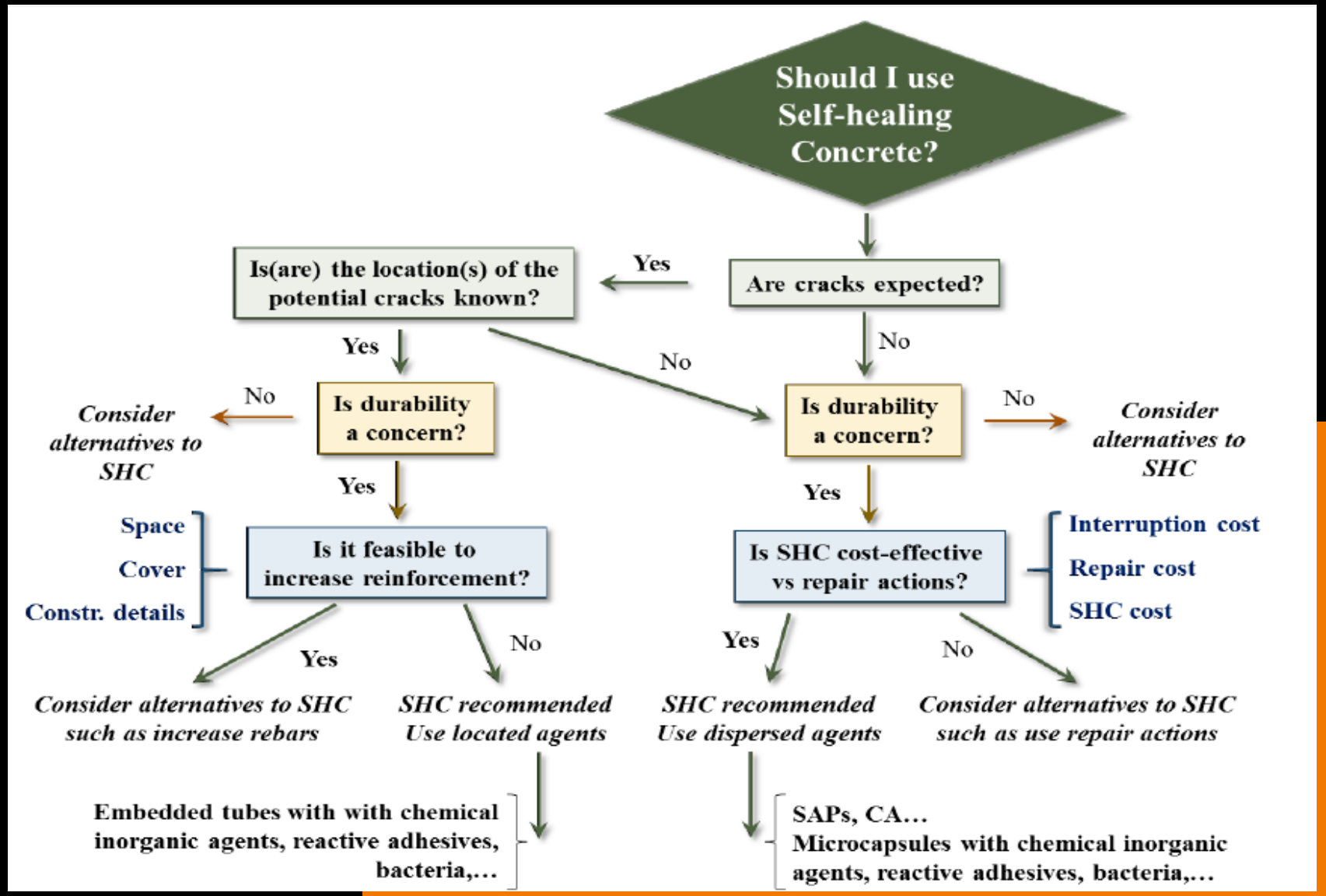
- Self healing is used on structures to prevent cracks on concrete.
- It can be used to strengthen both existing and new types of structural building.

- Long lasting river banks
- High strength buildings with more bearing capacity.
- This can provide ways to durable roads.

- Self healing concrete can be used for sectors such as tunnel lining, structural basements walls, highways, bridges, concrete floors and marine structures.

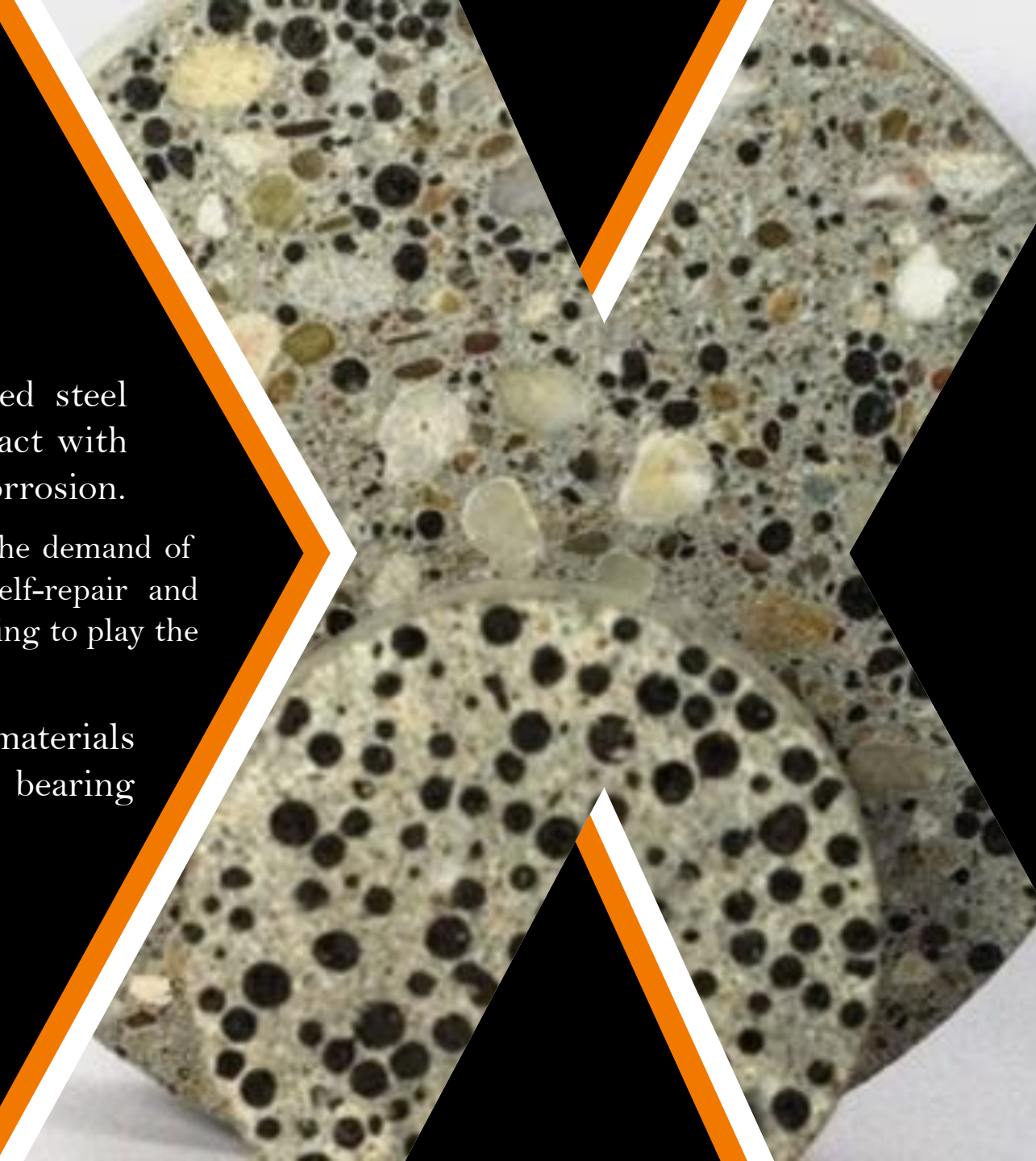
Conclusion

FINAL DECISION ABOUT SHOULD WE USE SELF-HEALING CONCRETE?



CONCLUSION

- Hence self healing concrete is crack resistant, which protects the concrete and reinforcement from cracks and corrosion.
- It prevents water to percolate into reinforced steel concrete and hence it does not comes in contact with reinforcement, prevents reinforcement from corrosion.
- Self-healing concrete is the best solution for the demand of sustainable concrete due to its ability of self-repair and durability. In future, self-healing concrete is going to play the most important role in concrete technology.
- It increases durability of various building materials and give them high strength for more bearing capacity and increase life of building.
- Microbial concrete technology has proved to be better than many conventional technologies because of its eco-friendly nature and self-healing abilities. It increases the life span of the structure.



Thank You !