Using chemically treated grape bark fibers in sustainable concrete

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1. Introduction

The increasing demand and consumption in various sectors such as industry, mineral resources, fossil fuels and agriculture resulting from the population increase around the world, in addition to generating huge amounts of waste resulting from these sectors, made sustainable development become an
inevitable priority to maintain natural resources and try to reduce the negative impact of these sectors on the environment in order to balance the growth of industry and the ability of the atmosphere to withstand this negative impact.
The use of waste materials as useful engineering materials after processing them in accordance with the design requirements may contribute to preserving the environment, as it, in one way or another, reduces the volume of waste.
Currently, the sustainable concrete development is moving towards a new path, which is the utilize of vegetal fibers in concrete production by using it in different proportions to reach better concrete properties and to investigate the ability of green concrete to be utilized as an alternative to traditional buildings and facilities concrete..
This research aims to present and investigate a new waste material utilized as a fiber material added to the concrete. The new, waste material that will be investigated is **grape bark**.
Several standard tests conducted according to the "American Society for Testing and Materials" (ASTM) standards for concrete samples prepared from grape bark fiber concrete and normal concrete.
Exhaustion of mineral aggregates, Energy consumption resulting from aggregate production and carbon dioxide emission leads to the search for alternative resources that can be used to maintain and possibly improve the mechanical properties of concrete.
This proposal aims to investigate the effect of grape bark on the density, absorption%, and voids %[1], compression strength[2],
splitting tensile strength[3], flexural strength[4], and the resistance of frequent freeze-thaw cycles for concrete samples[5]. Furthermore, it provides a new mix design aim to

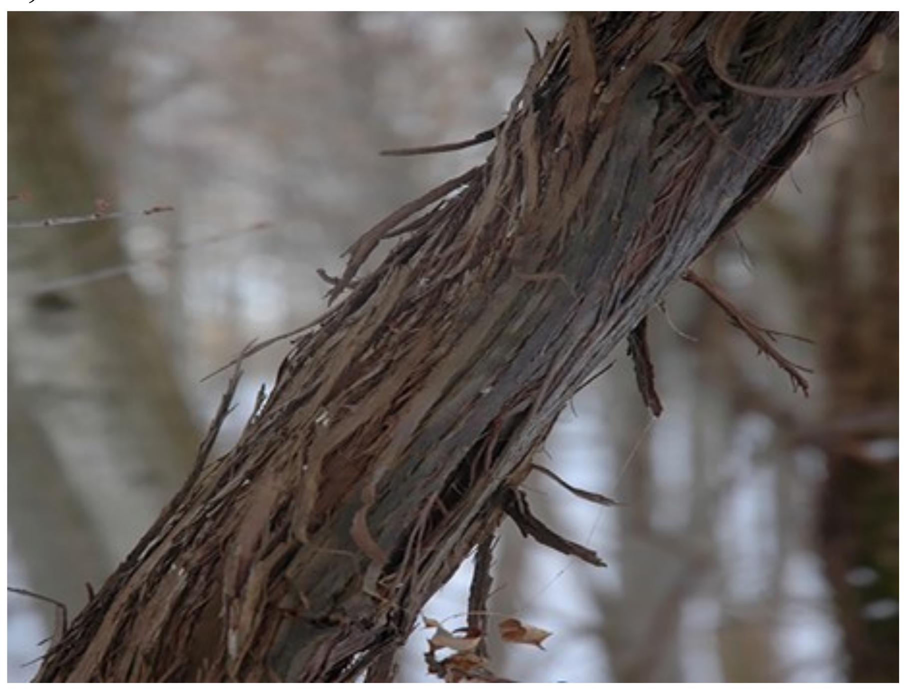
Fig1. Grapevine before peeling the bark

2. Experimental Program

2.1 Grape bark fiber preparation:

Different lengths of the bark were approved to maintain its randomness as a waste material,
but at the same time as a material that can be added to the concrete mix.
The lengths of the fibers ranged was between (2 mm to 50 mm).


Fig2. Grape bark random lengths

2.2 Grape bark chemical treatment:

The grape bark fibers were Immersed in **NAOH** for 24 hours at a concentration of 2.5% to comply the international definition of fibers concrete.
A soapy shining texture were noticed after the alkaline treatment. A 40°C electric oven were used for 90 minutes to dry the fibers.

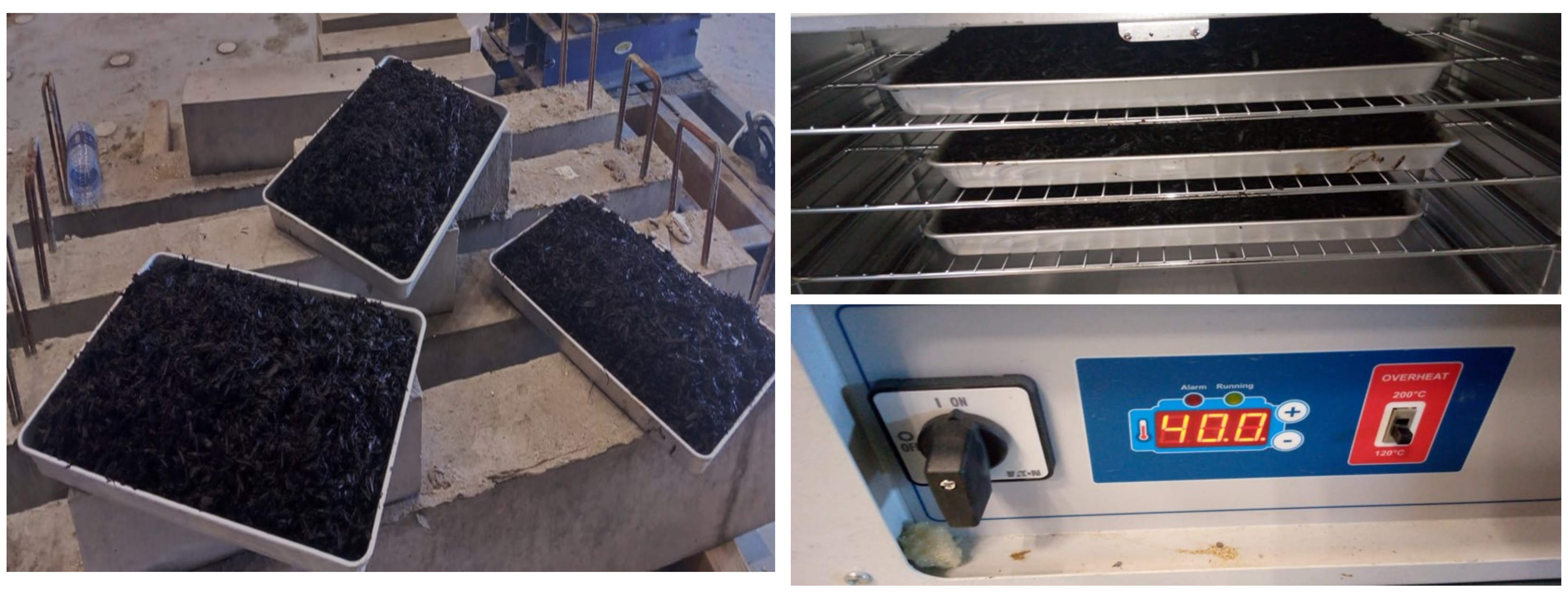

Fig3. Grape bark chemical treatment

2.3 Test specimens:

To investigate the applicability and effectiveness of using a grape bark as a new fiber type, six percentages of vegetable fiber[0%, 0.5%, 1%, 1.5%, 2%, 2.5%] " percentage from the mix mass" were examined to explore the effect of this new fiber on the mechanical properties of the concrete.
Samples were casted to figure out these mechanical properties with 15 cm slump (high slump) because the bark fibers expected to push the mix to be drier while its percent increased, 90 samples were casted; 72 cylindrical samples with (10 cm * 20 cm) and 18 sample in shape of rectangular prisms with (15cm * 15cm * 60cm).

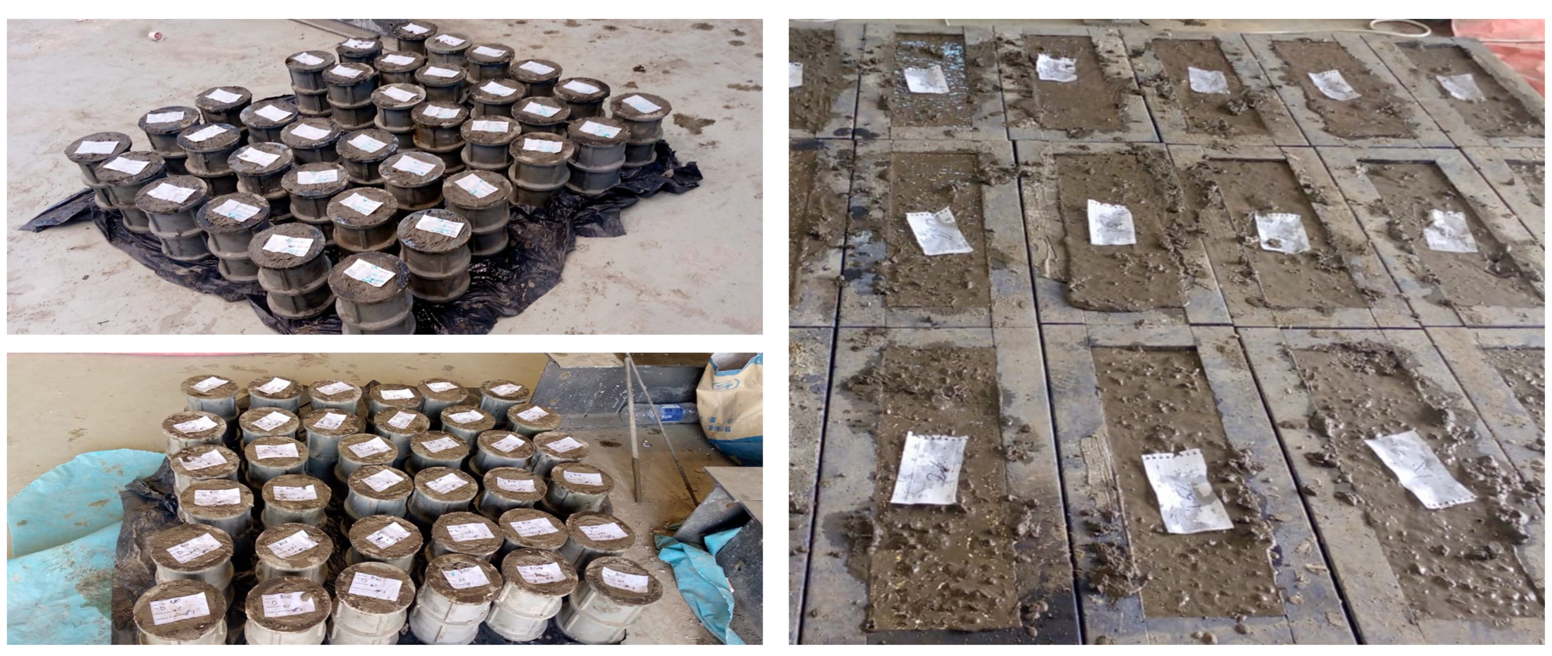
Fig3. Casted samples.

2.4 Major steps of <u>some tests</u> according to ASTM specifications:

<u>2.4.1 Density, Absorption, and Voids in Hardened Concrete:</u>

18 samples [3 samples for each percent] walked through many steps [Oven dried, Immersed for 24 hours in 20 C water, Boiled for 5 hours and suspended in water balance], the following figures show the test process:

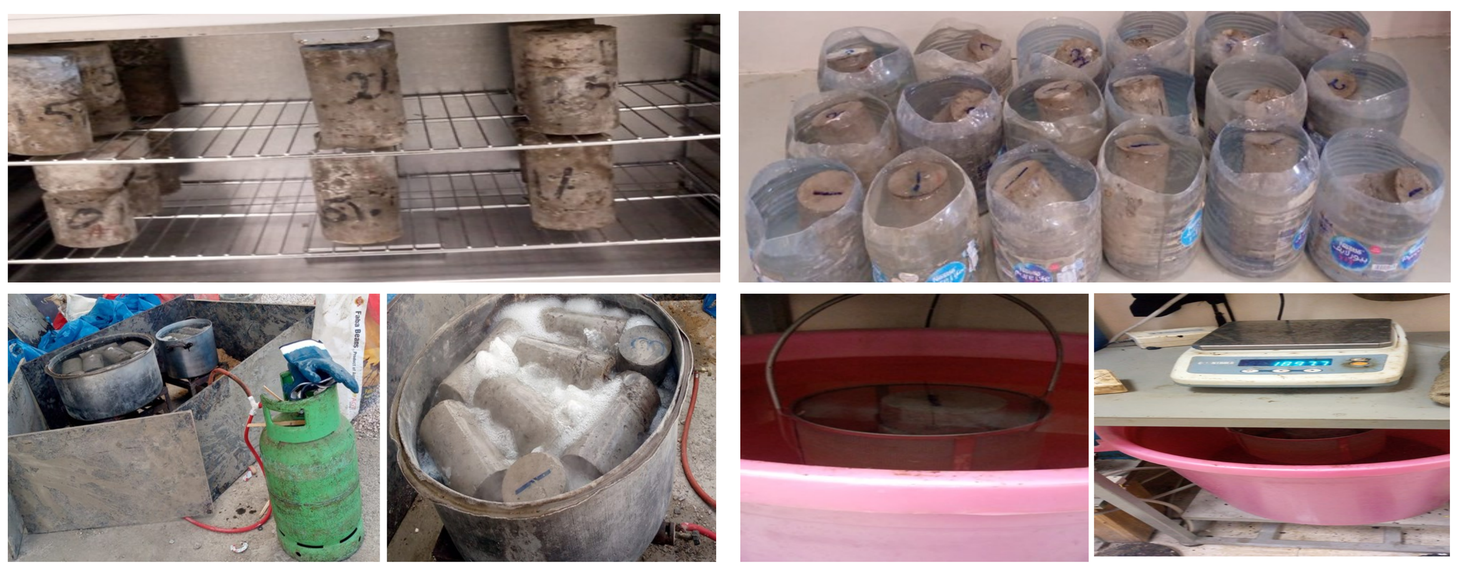
Fig5. Density, Absorption% and void % process.

<u>2.4.2 Resistance of Concrete to Rapid Freezing and Thawing:</u>

18 samples [3 samples for each percent] were stored for 14 days, then immersed with saturated lime water (**$CaOH_2$**) at ($23^{o} \pm 2$) for 48 hours before the test.
Using the Ultra Pulse Velocity (UPV) apparatus, the fundamental transverse frequency were measured.
The samples were placed in a plastic jars with dimensions (21cm* 11cm) with a small bulge at the bottom to lift the sample to ensure that surrounded the specimens all around with a 5 mm water shell.
The samples were placed in the rabid freeze thaw machine and programed starting with the thaw phase, the fundamental transverse frequency has been re-measured each **<u>29 cycles</u>** [10 days and 20 hours].

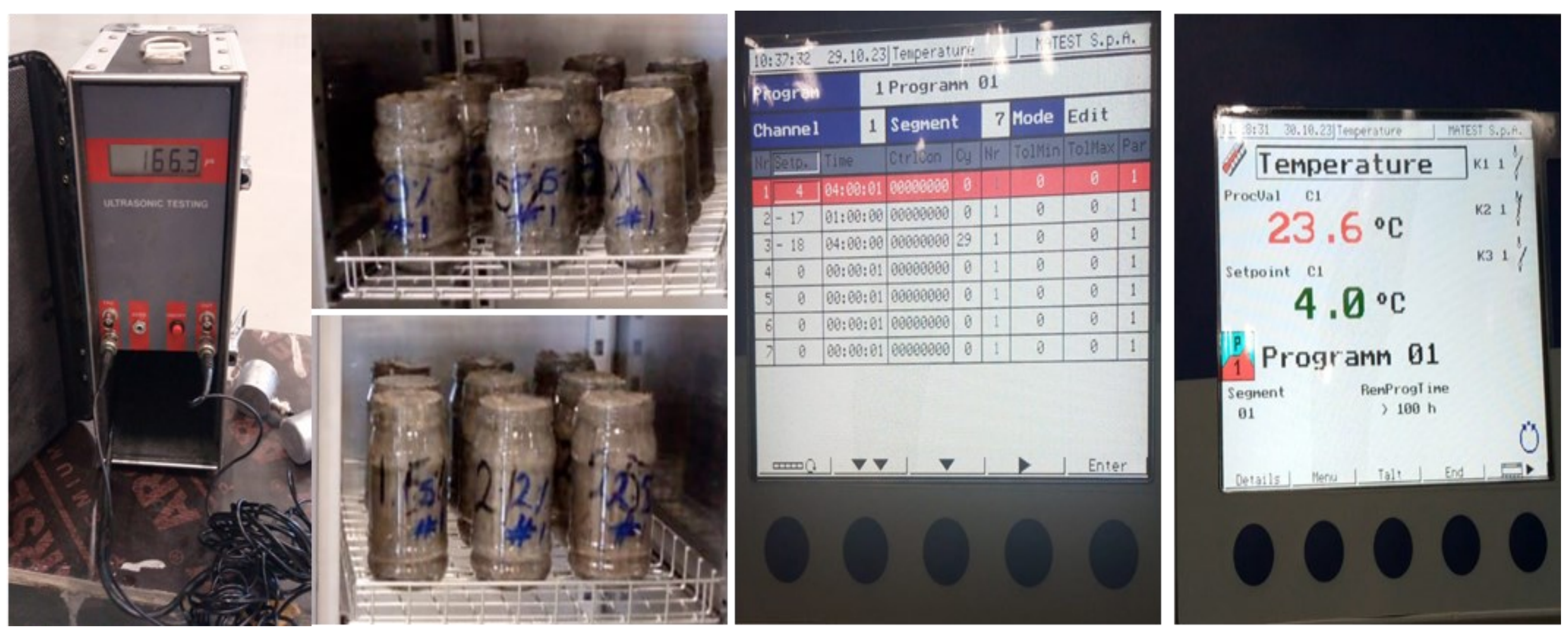

Fig5. Main phases at resistance of concrete to rapid freezing and thawing process.

<u>2.4.3 Compressive Strength of Cylindrical Concrete Specimens:</u>

A compressive axial load were applied on the 18 specimens [3 samples for each percent] to failure using the MTS apparatus, the samples was capped both ends with gypsum according to the ASTM to ensure the uniform distribution of the load.

Using this device was due to it's displays the behavior of the sample at each part of second during the gradual application of load to it, as it contributes to understanding how concrete samples are affected by the load applied to them by displaying the load-deflection curve for each sample.
This device can be used in several experiments, including the compression strength, the tensile strength of steel and composite materials, flexural strength test for concrete specimens, and more.

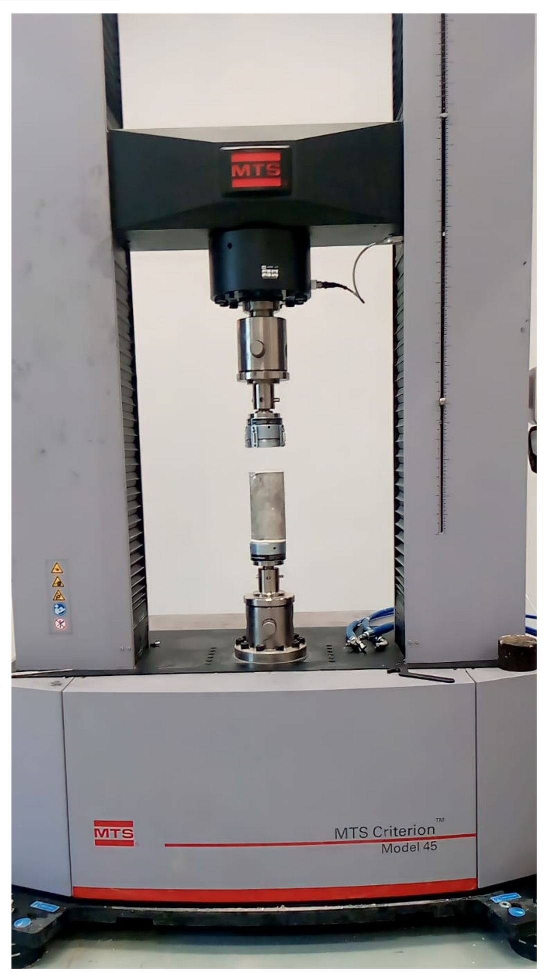
Fig6. compression test using MTS apparatus

<u>2.4.3 Splitting Tensile Strength of Cylindrical Concrete specimens :</u>

Triaxial compression was applied using a splitting tensile apparatus to determine the splitting tensile strength of the specimens, a triaxial compression was used to lead to tensile failure instead of compressive failure.

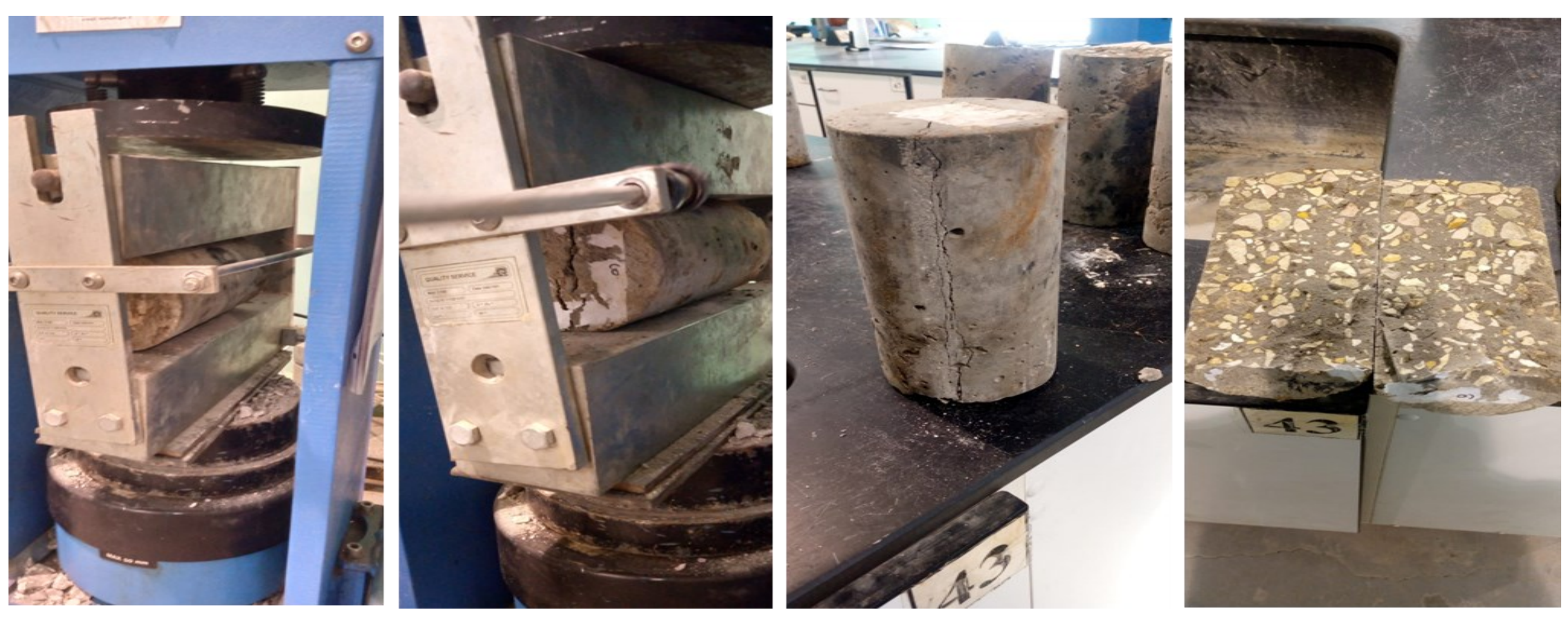
Fig7. Splitting tensile test process