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# Study of Biomedical Waste Ash in Concrete: a review

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**Abstract:** Biomedical Waste is combination of medical waste from various sources like hospitals research center clinics etc. Generally biomedical waste is burned in incineration plant and produce incineration biomedical waste ash (IBWA).It is consider dangerous because it may contain toxic substances such as heavy metals(Hazardous waste). For our study a biomedical waste was collected from the super hygenic treatment plant, Nagpur.
We will replaced cement by biomedical waste ash with 3%,6%,9%,12%,15% respectively. Total 105 standard size cube where to be cast within 1:1.5:3 (M20). Equal number of cube were cured for 3 ,7,28,56,90 days.
In these project we will do compressive strength, flexural strength, split tensile strength. Chemical composition test are XRD (X-ray diffraction), XRF (X-ray fluoresce) spectrometer analysis, SEM (Scaning electron microscope) were carried.

**Keyword:** Biomedical waste, cement, waste needles, sustainability.

## 1. Introduction

Concrete revolution is growing every day and hence use of natural sources consumption also increased. Using these natural resources with a limited amount of it but also creates an unbalance in nature. Biomedical waste, produces from medical sources and other activities. Toxicity and hazards of biomedical waste is generally depend upon its origin On the other hand, in the construction and development of infrastructure, concrete is one of the primary materials. Waste can be utilized in concrete either as a substitute for aggregates or cement, fibers or fillers. Waste can be used to replace the aggregate in construction, as it is diffi- cult to use as a substitute for cement.70% of concrete volume is aggregate, and given that large quantities of waste can be reused, this is a critical choice for countries with a shortage of minerals to avoid consumption of raw materials that are rare in some countries.

Hospital waste ash in cement origin can be used as construction material. It can also be used as a preserve agent in road and asphalt pavements. Along with natural resource shortage, poisonous waste disposal is also big issue nowadays. With the massive increase in the amount of waste needing removal increase in transportation, a serious short- age of dumping sites and dumping expenses necessitates the requirement for effective utilization of these wastes. Huge studies were previously reported regarding the use of various waste materials in concrete mixes.

The Cement stabilization method for waste treatment is dependable, and its use in building products has since become a common method of reducing environmental pollution and recycling waste. this research work aims at inves- tigating the compressive strength of concrete cylinder made with partial replacement of cement with fly ash from bio-medical waste.

## 2. CHEMICAL TEST

### 2.1. XRD(X-ray diffraction)

X-ray diffraction, or XRD, is a technique for study the atomic or molecular structure of materials. It is non-devastative, and works most effectively with materials that are wholly, or part, crystalline. The technique is often known as x-ray talc diffraction because the material being analyzed typically is a ultimately ground down to a uniform state.

Emission is when light bends slightly as it passes around the edge of an object encounters an obstacle or aperture.

The degree to which it occurs depends on the relative size of a wavelength compared to the dimensions of the barrier or open it encounters.

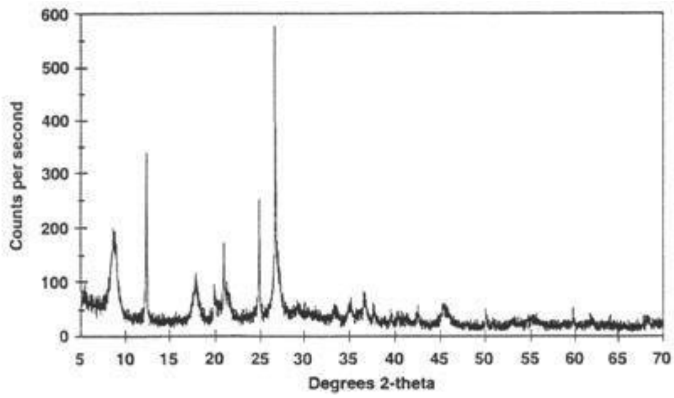
**How does it work?**

X-rays are a form of electromagnetic emission include wavelengths determineable in nanometres (a nanometre is equivalent to one billionth of a metre). When homogenous x- rays scatter from a substance with a structure on this scale, it causes interferences. This outcome in a pattern of lower and higher intensities due to constructive and destructive intrusion according to Braggs law.

With crystal clear substances, the pattern creates three-dimensional shavings of diffraction in response to x-ray wavelengths, like the spacing of planes in a crystal lattice. This process is known as productive interference and is used as a technique for studying crystal structures and atomic spacing. All diffraction methods start with the release of x-rays from a cathode tube or revolving target, which is then focused at a sample. By collecting the diffracted x-rays, you can examine the sample's structure. This is possible because each mineral has its unique set of d-position. D-position are the distances between planes of atoms, which cause diffraction peaks.

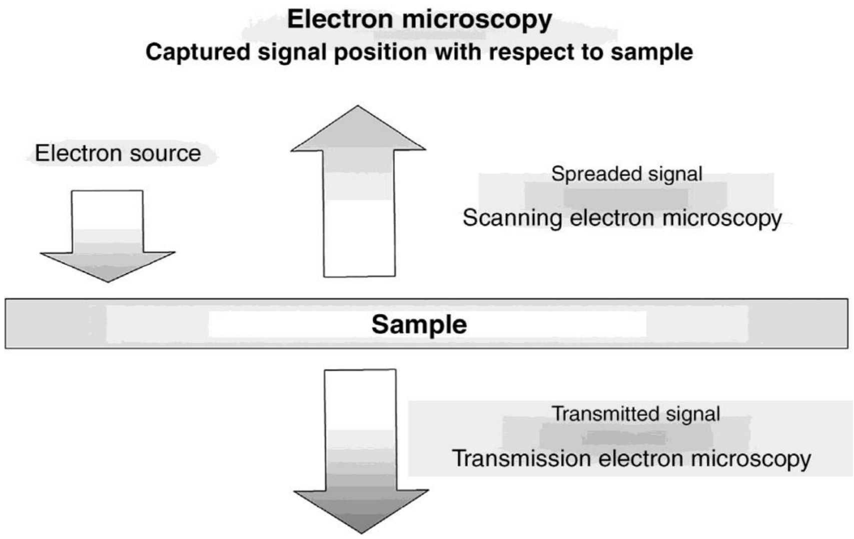
There are standard reference patterns of d-position, which act as a comparison when using XRD to identify the structure of a sample substance.

The way that x-rays feast the atomic structure of crystals is based on Bragg's law.




## 2.2. SEM (Scanning Electron Microscope)

The scanning electron microscope (SEM) involve of two major parts, the column and the container. The column is the extension that the electrons traverse from their emission until they reach the sample, where the installed detectors will capture the scattered.



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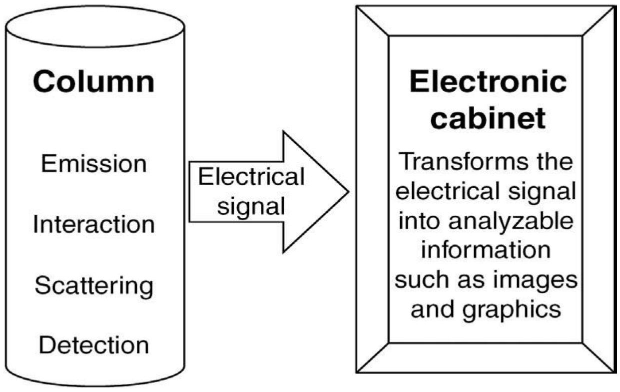



The position of the catch signal defines the two types of electron microscopy.
The electron column shows all of the elements that concern to the signals from their emission until their capture. In the container, the signals are processed for easy display.

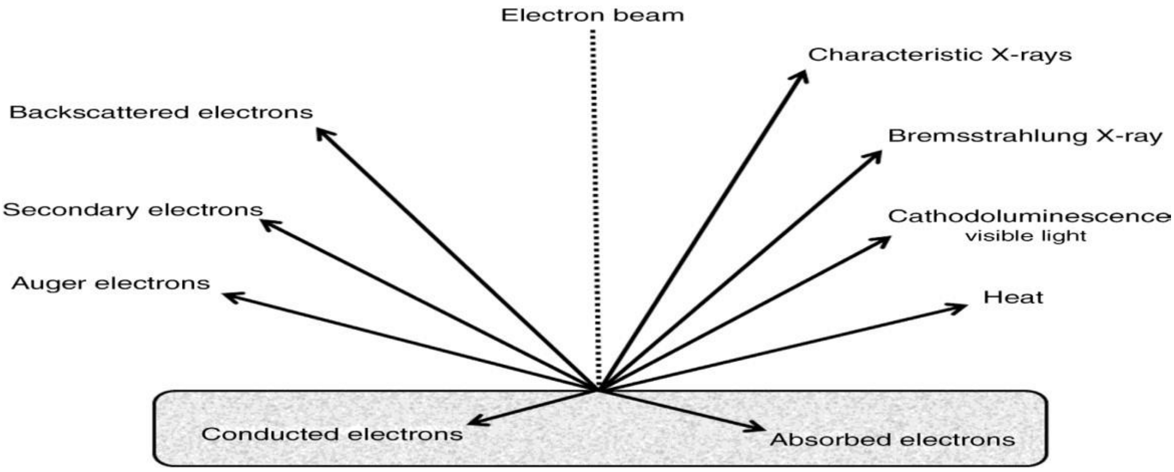
signals resulting from the communication between the electrons and the sample. The pointer are energy transducers that transform one type of signal into an electrical signal, which is sent to the control cabinet. The control container has electronic systems able to calibrate the electrical signals sent by the pointer and turn them into analyzable information such as images and graphs.

Table 1.1 Comparison of the Electron Sources

| **Filament** | | | **Field Emission** | |
|---|---|---|---|---|
| | **Tungsten** | **$LaB_6$** | **Thermal** | **Cold** |
| Operating temperature (K) | 2800 | 1900 | 1800 | 300 |
| Brightness [A/(cm sr kV)] | 104 | 105 | 107 | 2 × 107 |
| Required vacuum (Torr) | 10−4 | 10−6 | 10−9 | 10−10 |
| Energy distribution (eV) | 2.5 | 1.5 | 1.0 | 0.25 |
| Lifetime (h) | 100 | 1000 | 5000 | 2000 |
| Filament regeneration | No | No | No | Every 6–8 h |
| Emission current/area (A/cm2) | 3 | 30 | 5.300 | 17.000 |

**Using the SEM**

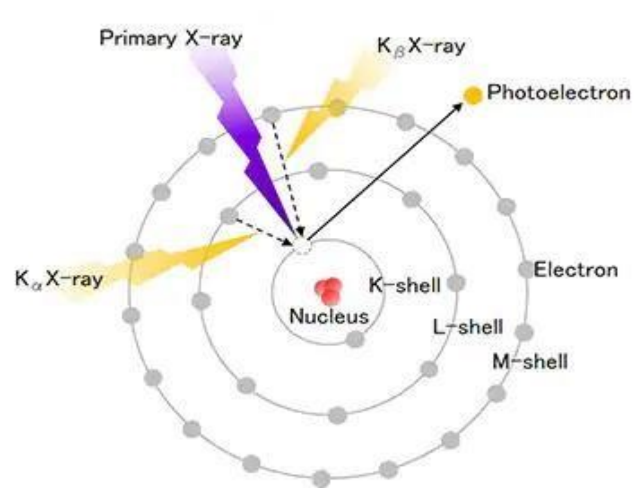
The SEM is used to notice and change the sample's surface. It is used to capture and in- terpret some signals emitted during the interaction of the electron beam with the sample among these signals, there are electrons [auger electrons, secondary electrons.


Electron beam
Characteristic X-rays
Backscattered electrons
Bremsstrahlung X-ray
Secondary electrons
Cathodoluminescence
visible light
Auger electrons
Heat
Conducted electrons
Absorbed electrons

### 2.3. XRF (X-ray Fluorescence)

X-rays are a type of electromagnetic wave equivalent to visible light rays but with an extremely short wavelength that measures from 100A to 0.1A. Collated to normal electromagnetic waves, X-rays easily go through substances and become stronger as the atomic number of a substance through which it passes decreases. X-ray fluorescence analysis is a method that uses attribute X-rays (fluorescent X-rays) generated when X-rays illuminate a substance. Fluorescent X-rays are electromagnetic waves that are created when irradiated X-rays force inner-shell electrons of the composing atoms to an outer shell and outer shell electrons punctually move to inner shells to fill the vacancies. It shows how fluorescent X-rays are produced. These fluorescent X-rays possess energies that are characteristic to each type of element enabling subjective analysis by using Moseley's law and quantitative analysis by using the intensity (number of photons) of each X-ray energy.

X-ray fluorescence analysis can be study of as spectrochemical analysis within an X-ray region. It has the same attribute as atomic soaking up spectrometry and optical emission spectrometry except that the sample does not need to be melt in a solution to be a examine. Flameless atomic attribute spectrometry (FLAAS) atomizes the elements in a sample in a 2000 to 3000C flame. ICP optical emission spectrometry (ICP-OES), animate a sample in a 6000 to 9000C plasma flame. X-ray fluorescence likewise animate the sample to acquired information from X-rays.




**Physical Testing**

1. **Compressive strength test:**

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Compressive strength for concrete mixes at 7, 14, and 28 days . The results of compressive strength test revealed that the compressive strength of WNs-concrete increased slightly with increasing the ratio of WNs small pieces, but still lower than that for the plain concrete mix at 14- and 28-days curing days. However, the minimum value of compressive strength was (34 MPa) for 2% replacement of aggregates at 7 days of curing age which was higher than the minimum value (17.4MPa) of lightweight concrete for structural application. This behavior could be attributed to the lower density of the needles compared to sand density, their strength, and their smooth texture.

## 2. Flexural strength :

flexural strength test for the WNs-concrete mixes are presented in Figure. The results show that the flexural strength of WNs-concrete mixes increased with increasing the ratio of WNs in these mixes. At 28-day cur- ing, flexural strength for all mixes, became high- er than the plain concrete mix. Noori and Ibra- him reported that when iron waste was used as a fine aggregate, the flexural tensile strength gradually increased with the waste iron percent- age until 12%.

## 3. Spilt tensile strength:

Test is carried out by placing a cylindrical specimen horizontally between the loading surfaces of the compression test machine until failure of the specimen along the vertical diameter. The split tensile test is carried out on cylindrical specimen. The specimen is of size 100 mm diameters with 150mm length. The split tensile strength of concrete is given by the formula $Ft = 2 P/\Pi d L N/mm^2$

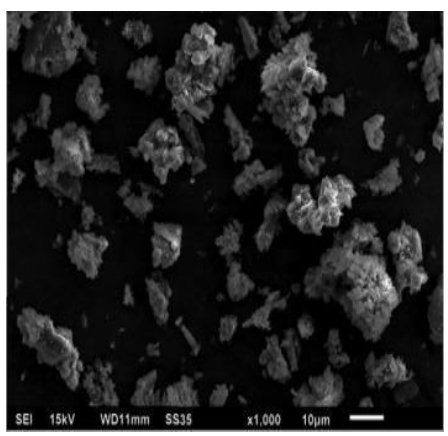
Where,P = failure load of specimen in Newton's d

d = diameter of specimen in mm L = length of the specimen in mm


**Material required for project :**

## 1. Biomedical Waste Ash:

Biomedical waste ash generated due to the incineration of biomedical waste contains large amounts of heavy metals and polycyclic aromatic hydrocarbons Biomedical waste ash may be solid or liquid. Examples of contagious waste include discarded blood, sharps, undesirable microbiological cultures and stocks, noticeable body parts (including those as a result deformity), other human or animal tissue, used bandages and dressings, discarded gloves, other medical supplies that may have been in connection with blood and body fluids, and laboratory waste that expose the attribute described above. Waste sharps include potentially polluted used (and unused discarded) needles, scalpels, lancets and other devices capable of penetrating skin.




## 2. Fine aggregate

Aggregate is the powdered material used to produce concrete or mortar and when the particles of the powdered material are so fine that they pass through a 4.75mm sieve, it is called fine aggregate. It is broadly used in the construction industry to increase the volume of concrete, thus it is a cost saving material and you should know everything about the fine aggregate size, its density and group zone to find the best material.


M sand was used as fine aggregate of grading zone II. The properties of fine aggregate are shown in table below:IS code 383:1987

**Table :Properties of Fine Aggregate**

| Sr. No | Property | Result |
|---|---|---|
| 1. | Bulk Density | 1625 kg/$m^3$ |
| 2. | Fineness modulus | 3.80 |
| 3. | Specific gravity | 2.67 |
| 4. | Water absorption | 1.2 |

## 3. Coarse aggregate

Coarse aggregates are any particles greater than 0.19 inch, but generally range between 0.38 and 1.5 inches in diameter. Gravels compose the majority of coarse aggregate used in concrete with crushed stone making up most of the balance.

Coarse aggregate of size 20 mm of crushed stone locally available confirming to IS 383- 1987 was used

**Table . Properties of Coarse Aggregate**

| Sr. No | Property | Result |
|---|---|---|
| 1. | Bulk Density | 1525 kg/$m^3$ |
| 2. | Fineness modulus | 3.67 |
| 3. | Specific gravity | 2.89 |
| 4. | Water absorption | 0.46 % |

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## 4. Cement

Cements used in construction are generally inorganic, often lime or calcium silicate based, which can be distinguish as non-hydraulic or hydraulic respectively, depending on the capacity of the cement to set in the existence of water (see hydraulic and non-hydraulic lime plaster).
A cement is a binder, a substance used for construction that sets, hardens, and stick to other materials to bind them together. Cement is hardly used on its own, but rather to bind sand and gravel (aggregate) together. Cement mixed with fine aggregate generate mortar for masonry, or with sand and gravel, generate concrete. Concrete is the most widely used material in existing and is behind only water as the planet's most-consumed resource

Ordinary Portland cement of 43 grade confirming to IS 4031-1988 was used in the present study. The various properties of cement are resulted as shown in Table below:

**Table: Properties of Cement**

| S.No. | Property | Result |
|---|---|---|
| 1 | Normal consistency | 33 % |
| 2 | Initial setting time | 42 min |
| 3 | Specific gravity | 9.99 |
| 4 | Fineness of cement | 5 % |
| 5 | Specific area | 3250cm$^2$/gm |
| 6 | Soundness of cement | 1.00 mm |

### M20 grade of concrete (IS 10262-2009)

M20 concrete is a minimal nominal mix of concrete used in RCC construction of structural members such as footings, foundations, and columns, as well as flexural members such as beams and slabs.

The grade M20 concrete means M represent for concrete mix design, and the numerical value 20 indicate their compressive strength growth in 28 days after casting and adequate curing. Their characteristic compressive strength(fck) value, or compressive strength properties, is 20 N/mm2.

### Concrete mix ratio M20 grade

M20 concrete mix ratio is 1:1.5:3, composed of a mixture of cement, sand, and aggregate, with 1 part cement, 1.5 part sand, and 3 part aggregate or stone. To produce a concrete mix of M20 grade, 1 bag of cement is combined with 1.5 bags of sand and three bags of aggregate. Calculate the quantity of cement, sand, and aggregate in 1 m$^3$ of concrete with an M20 grade.

As we all know, when we place wet concrete, it hardens after a given amount of time (30 minutes to 10 hours) and the voids in the concrete are totally evaporated, resulting in a reduction in the volume of around 54 percent, implicit that the dry volume of concrete is raised by 54 %.
In M20, M denotes Mix and 20 stands for the characteristic compressive strength (fck) of that mix i.e. 20mpa. Cement, sand and aggregates are used for mixing in the proportion of 1 : 1.5 : 3. M20 denote mixture of cement, sand and aggregate which are get ready in such a way that a cement concrete cube of size 15 cm x 15 cm x 15 cm is formed with characteristic compressive strength (fck) of 20mpa while inspect it after being cured for 28 days.

The characteristic compressive strength (fck) denote the strength under which not over 5% of test results are expected to fail**.**

## Conclusion

- Characterization of IBWA shows that it possesses variety of particle sizes so it can be used in concrete production as filler material.
- The utilization of IBWA as partial replacement of sand in concrete solves the problem of inadequate space and high land disposal costs and thus keeping the environment free from pollution.
- This study aimed to investigate and evaluate the recycling of waste medical needles to partially replace the fine aggregate in concrete mixes.
- From environmental perspective, the results demonstrated an environmentally friendly sustainable approach for proper management of this hazardous medical waste ash.
- Therefore, it is concluded that biomedical waste ash has a good potential to be used in fresh concrete as partial replacement of cement leading to the reduced management of the waste and alternative material of cement.

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