RESIDUAL STRESS ANALYSIS OF CONCRETE POWDER SAMPLE USING X-RAY DIFFRACTOMETER (XRD)

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Abstract

The XRD technique for determining residual stresses in construction has been commonly utilized in the international scientific community for many years. Taking advantage of the concepts on which the technique is predicated, this study paper presents an advance within the latter utility by means of the laboratory calibration of the X-ray diffraction techniques in determining residual stresses. Using laboratory based or portable equipment, the XRD technique measures surface residual stresses by measuring the material's inter-atomic spacing. Laboratory X-rays have wavelengths of some order of angstroms (Å), which also has the same order of magnitude inter-atomic/inter-planar distances in polycrystalline solids. X-rays incoherence from a polycrystalline solid can critically interfere producing a diffracted beam. The angles at which the utmost diffracted intensities occur are measured. From these angles it's possible to get the inter-planar spacing (d), of the diffraction planes using Bragg's law. If residual stresses subsist within the sample, then the (d) spacing would be distinct from that of an unstressed sample. This difference is proportional to the magnitude of residual stress present. Also bi-axial residual stresses are measured using XRD. The accuracy of those techniques is heavily dependent upon good surface preparation and grain size/texture which has been briefly discussed during this paper.

Keywords: *Polycrystalline solids, Bragg's law, magnitude of residual stress, bi-axial residual stresses, grain size, XRD.*

1. INTRODUCTION

X-Ray powder diffraction is a quick analytical method and non-unfavourable method. It can offer facts on unit mobileular measurement and used for the identity of a crystalline fabric. It is primarily based totally on interference of monochromatic X-ray and a crystalline pattern. In XRD X-ray cause cathode ray tube, filtered to construct monochromatic radiation, collimated to pay attention and directed toward the pattern. The incident rays with the pattern produce diffracted ray after which the diffracted rays are detected.

Concrete along with segment one is viscoelastic cement stone (porous tough segment) and any other is the discrete segment or elastic aggregate, wherein diverse residences have an effect on the improvement of stresses and strains. Due to the same deformations on segment such non-homogeneous fabric cannot freely increase movement upon bodily and mechanical impacts and accordingly concrete receives an equilibrium situation of residual stresses.

Residual strain is that strain that is found in a frame with inside the absence of outside implemented masses and frame force. To enhance substances protection and sturdiness it's miles critical to manipulate residual strain. Residual strain persuade small modifications with inside the crystal lattice spacing of a fabric, which may be deliver away with the aid of using XRD with a completely excessive sensitivity. Through XRD the location of a appropriate diffraction height is measured in a positive factor beneath earth version and orientation of the pattern associated with the incident X-ray beam. From this spacing with inside the exceptional direction, associated elastic stress may be obtained. From every stress facts compressive strain or tensile strain may be calculated.

2. LITERATURE REVIEW

Prof. N. K. Dhapekar, Prof. A.S. Majumdar, Dr. P. K.Gupta "Study of phase composition of Ordinary Portland Cement Concrete using X-Ray Diffraction" [1] This paper has been discussed about the approach of phase composition using XRD as alternative to various chemical methods. The main purpose of this research paper is to determine the different composition and constituents of ordinary Portland cement concrete samples. They choose water cement ratio as 0.55, 300gm of cement, 793gm of natural sand, 140gm of pozzolana fly ash and 1021gm of coarse aggregate for the mix. This XRD analysis revealed the presence of compounds and when water is added to cement each compound undergoes hydration and contributes to final concrete product. XRD analysis reveals the percentage of cement in sample-1 is 15% and for the sample-2 is 14% and the average is 14.5% is finally worked out in concrete mix. This technique may prove to be an effective for phase composition of concrete mix.

Prof. N. K. Dhapekar and Prof. D.M. Chopkar " Structural Health Monitoring of Ordinary Portland Cement Concrete Structures Using X-Ray Diffraction." [2] This is the experimental study which is performed on ordinary Portland cement concrete powder sample using X-Ray Diffraction. It reveals the auspicious approach for structural health monitoring of concrete structures. Using X-Ray diffraction analysis the potential presence of cement content and silica in ordinary Portland cement can be determined.

3. METHODOLOGY

The main challenge in calculations of residual stress is to understand the mechanical properties of concrete on its different phases and its physical characteristics. we will determine the strain values by deformations but we cannot obtain stress values by normal procedures. Also, we'd like to think about different stress conditions other then external loads like temperature, shrinkage etc., conditions applied on specimens while testing.

- **Residual Stresses Because Of Temperature Variation**

It is assumed that the coefficients of thermal expansion of concrete, its components, concrete composition and modulus of elasticity of concrete will be calculated supported the model physical and mechanical properties by applying conventional formulas. Approximate calculations of the residual stresses tried on three types:

1. Plane disk or linear model consisting of intercrossing cement stone and aggregate disk elements of absolute volumes.
2. Circular cylindered model.
3. Spherical model with the cement stone as outer shell and also the aggregate as core.

- · **Residual Stresses Because Of Shrinkage**

Residual stresses thanks to shrinkage may be determined by the link which obtained for residual thermal stresses. Shrinkage stresses are a permanent character and also the calculation of stresses must take under consideration the creep rate for the given concrete grade and time. There's no uniform temperature or shrinkage along concrete cross section and also the stresses obtained by assuming uniform distribution, residual stresses developed in fibers thanks to temperature gradients and shrinkage.

4. CONCLUSION

Residual stresses can be obtained by applying theory of elasticity formula on any of the three models using XRD technique. When residual stresses are determined by above mentioned three shaped models, these models show that the result obtained by the disk model provides the best estimate for practical purpose as in this case load applied on both cement paste and aggregate is approximately equal due to its shape. Also Stresses which are capable of causing cracking in the concrete can be produced by shrinkage and temperature change without any external loading.

Finally, this paper educates about a possible use of XRD technique to determine residual stresses which could help in understanding of structural components durability.

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