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A REVIEW PAPER ON ANALYSIS OF FERROCHROME SLAG AS AN EMBANKMENT AND PAVEMENT MATERIAL

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Abstract :In recent decades there has been fast increment in the modern waste materials and results yields because of the dynamic development pace of populace, improvement of industry and innovation and the development of commercialization. With the developing ecological pressure to lessen waste and contamination, intensive research considers have been led to investigate all reasonable reuse strategies. The use of industrial solid waste as a partial replacement of raw materials in construction activities not only saves landfill space but also reduces the demand for extraction of natural raw materials. Various efforts are being made to use the industrial wastes as an alternate construction material to conserve the natural resources and effective utilization of the industrial waste to sustain the industrialization. But limited attempts have been made to characterize Indian ferrochrome slag as a construction material. Ferrochrome slag is a result from the creation of chrome. There are natural and economic advantages in considering slags to be a conceivably valuable asset as opposed to as waste items. This paper exhibits a review of the ongoing advances of the utilization of ferrochrome slag in different structural designing applications, for example, street development, and bond and solid enterprises.

Index Terms-Construction, ferrochrome, slag, street, wastes, commercialization.

I. INTRODUCTION

Ferrochrome slag is a waste inorganic material however it very well may be used in different work to create on affordable perspective and making the earth contamination free [1]. The best client of natural occurring resources is the fast creating division of the development business. This raises significant worries on the exhausting of these assets at a disturbing rate which makes genuine dangers the ecological balance. Because of the expansion on the planet populaces, the quick developing of the modern, residential, business and innovative exercises, the related age of the solid wastes are expanding significantly making an extra burden on the earth.Globally, generation of Ferrochrome slag is 6.5 to 9.5 million tons and increased by 2.8 to 3 % per annum (Kauppi and Peka, 2007). It contains 13-39% of SiO2, 10-29% of MgO, 16-43% of Al2O3, 1-6% of CaO, 6-18% of Chromium, 3-11% of Iron and other minerals. The utilization of the modern slag items, for example, FeCr slag in advantageous applications, for example, materials in building and pavement construction decreases the exhaustion of the natural resources and it brings about positive ecological impacts. The FeCr slag has physical properties like natural aggregates which makes it an appropriate material for structural designing applications. This paper shows a review of the ongoing advances of the utilization of ferrochrome slag in different structural designing applications, for example, road development, and cement and concrete work.FeCr slag is named ferrous slag under iron-composite slags. Genuinely limited quantity of this material is utilized in helpful applications while most by far of the material delivered every year in the site which cannot being used further.

USE OF FERROCHROME (FeCr) SLAG IN CONCRETE

Concrete is a development material, made by mixing materials like cement, sand, aggregate and water in clear extents. Very restricted investigations were led to examine the impact of FeCr slag on the properties of mortars and concrete. These examinations were centered for the most part around the utilization of FeCr slag as total substitute. Zelić examined the properties of solid asphalts arranged with ferrochromium slag as solid total. The outcomes demonstrated that the 28-day compressive quality of the solid made with unique un-fractioned slag and with standard limestone as total arrived at the estimations of 57 MPa and 36.7 MPa, individually. The properties of cement was explored by Gencel et al. under joined impacts of fly debris as bond substitution and ferrochrome slag as total substitute. Concrete was supplanted with fly debris at the proportion of 10, 20, and 30 wt% though coarse limestone totals were supplant with coarse ferrochromium total at the proportion of 25, 50, and 75 wt%. The outcomes from the investigation uncovered that ferrochromium totals increment the quality of cement and furthermore the grating wears opposition while it has irrelevant effect on the porosity and water retention of cement. A Study which was completed on the impact of microsilica expansion inside a low concrete castables framework of calcined bauxite and ferrochrome slag demonstrated that slag containing castables accomplished great warm properties, for example, warm stun opposition, lasting straight change, and pyrometric cone identical. Various specialists examined the properties of typical and high quality cement made with FeCr slag as a total. The outcomes demonstrated that substitution up to 75% of FeCr slag in lieu of fine totals improved the quality of cement contrasted and regular cement. In an ongoing report, Acharya and Patro explored the impact of utilizing ferrochrome debris (FCA) and lime dust in solid properties. Up to 40% of FCA was utilized as bond substitution in solid blends in four distinct substitutions at an interim of 10%. FCA

was altered with lime residue to upgrade the presentation of cement in which substitution of lime was considered as 7% in the wake of contemplating its impact on mixed bond based cement. The outcomes from Acharya and Patro study demonstrated that substitution of OPC up to 47% by FCA (40%) and lime dust (7%) has practically identical positive effect on the 28 days quality and calculable effect on long haul quality properties.

APPLICATION OF FERROCHROME (FECR) SLAG IN ROAD CONSTRUCTION

Stabilization is done by the use of strained compaction, its proper proportioning and the addition of any stabilizing agent. It deals with the substantial and physio chemical methods to make the soil stabilize. Various kinds of slag find wide acknowledgment in street development industry as total in adaptable and inflexible asphalts, hot black-top blends and as a material in base and subbase layers. Slags have prevalent properties, for example, volume security; high volume mass, great scraped spot protection from wear and crushability which make it a reasonable material for street development.

The principal utilization of slag as a total in black-top blends goes back to 1969 , when a preliminary street area was worked in Toronto, on which steel slag was utilized as a total in base course and street blacktop surfaces. The contemplated black-top blends have shown generally excellent properties as far as bearing limit, protection from outer effects, and toughness. In the most recent decade, the potential use of FeCr as an elective total in asphalts and street development has been examined. In 2001, Lind et al researched the natural effect of FeCr slag in street development. The outcomes showed that FeCr slag is protected to use as a material in street development. The examination directed by Zelic on the utilization of FeCr slag as solid total in solid asphalt presumed that the strengthened slag concrete is reasonable for wearing courses of solid asphalts for traffic classes 1 and 2 where carbonate stone material doesn't satisfy the guideline specialized prerequisites for bond solid section asphalts as indicated by the Croatian standard. Yilmaz and Karaşahincontemplated the mechanical properties of FeCr slag in granular layers of adaptable asphalts. The test program comprised of two sections: 1) investigation of thephysical and concoction properties of slag, and 2) investigation of the mechanical properties of examples made with FeCrslag and limestone as total. Test outcomes demonstrated that the physical properties of the slag, for example, the LA and CBR esteems, and high ice opposition meet the prerequisites of the totals for granularlayers of adaptable asphalts which qualifyFeCr slag as total appropriate for asphaltlayers.

II. BACKGROUND STUDIES

Environmental impact assessment studies have been conducted for using ferrochrome slag in pavement construction. The migration of chromium elements from ferrochrome slag to the underlying soil was very low [3]. Gravity separation and magnetic separation methods were found to be effective for recovery of Cr from the ferrochrome slag. However it’s been applied in India for safe disposal [2,4].

Dissolution characteristics for various conditions and pollution threat of the ferrochrome arc furnace dust (FAFD) were studied by TCLP. TCLP results showed that FAFD had a potential value of9.8mg / lit above the permissible limits of 5mg / lit. Stabilization / solidification of FAFD reduce leaching of metal concentration to allow safe disposal [5]. Bag filter dust obtained from the South African ferrochrome slag industry contains high contents of Cr (VI). The immobilization of Cr (VI)was done by mixing BAF with different proportion of crushed ferrochrome, electric arc furnace, Portland cement to from solid matrix structure like cement blocks and clay fire bricks. Clay bricks are the preferred form for the stabilization of ferrochrome BFD [6].

Encapsulation of solid waste like ferrochrome slag by Portland cement and the available cementitious material to form a massive matrix structure like concrete can mitigate the leaching of chromium in the surrounding environment [7].High carbon ferrochromium as an alternative material for the manufacture of various concrete pavement compounds in accordance with Croatian standards. Ferro chrome slag pavements offer finer possibilities than conventional ones due to the high price rate of igneous rocks [8]. The rough textureof the oxidizing stainless steel provides good bonding and it can be replaceable up to 100% for conventional aggregate in concrete. The leaching of heavy metals from slag-based concrete was not detected [9]. Stainless steel by-products were used as fine and coarse aggregates instead of virgin aggregates to make self-compact concrete. Oxidizing slag can replace up to 100% as coarse aggregate and 30% of cement in self compacting concrete [10]. Compatibility of Ferrochrome Slag Coarse aggregate in M20 grade concrete from partial to complete replacement of conventional aggregate was studied. All strength parameters increased to 75% replacement then decreased at 100% restoration[11].

Destructive and non-destructive tests were performed on concrete made with water-cooled ferrochrome slag (WCFS). Strength evaluation studies have shown that the strength of WCFS is slightly lower compared to conventional aggregates [12].The strength parameters of ferrochromium slag are showing good results than traditional aggregates. So ferrochrome slag can be used instead of traditional crushed limestone aggregates. The use of ferrochrome slag saves costly material and natural resources in road construction. The leaching studies are carried to assess the efficacy of leaching in slag indicates that it is within permissible limits and in non-hazardous environmental materials [13]. Ferrochrome slag was used as coarse aggregate(conventional lime stone) and total aggregate with neat and polymer modified binders. The Marshall Stability test and tensile strength tests showed that bituminous mixtures containing ferrochrome slag as coarse aggregate has higher stability than other mixtures. The slag containing mixtures have lower flow values. Laboratory tests have shown that ferrochrome slag as filler shows better results than traditional limestone filler in hot mix asphalt [14].

III. MATERIALS TO BE USED

- Ferrochrome slag (FS): - Ferrochrome (FeCr) slag is by product from the production of Ferrochrome, an

essential component in stainless steel industry. An amount of 1.1 to 1.6 ton of slag is produced for each ton of FeCr. FeCr metal is produced in electric-arc furnaces by a physical –chemical process from the oxide of chromium ore with coke as a reducing agent at temperatures between 1,500ºC to 1,700ºC. Both the molten FeCr and the slag flow out into ladles. After gravity separation from the metal, the molten slag, slowly cools in the air, forming a stable and dense crystalline product having an excellent mechanical properties similar to basalt. The granulated slag (size less than 4.75mm) samples result from water cooling of the slag whereas lumped slag(size between 8 to 20 mm) samples produced when slag is air-cooled. The FeCr slag is classified as ferrous slag under iron-alloy slags.

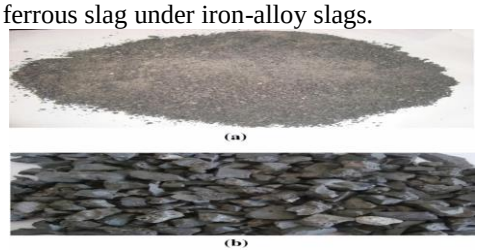

Fig. 1 Fine and coarse Ferrochrome slag

- **Red Mud (RM): -** Red mud is the waste industrial material that is obtained during extraction of alumina from bauxite ore. Alumina production process consists of crushing and grinding of bauxite with caustic liquor in ball mills.

Fig. 2 Red Mud

- **Red Soil (RS):-** Red soil is a type of soil that typically develops in warm, temperate, and humid climates and comprises approximately 13% of Earth's soils. It contains thin organic and organic-mineral layers of highly leached soil resting on a red layer of alluvium.

Fig. 3 Red Soil

- **Fly Ash (FA):-** The fly-ash is light weight coal combustion by product, which results from the combustion of ground or powdered bituminous coal, sub-bituminous coal or lignite coal.

Fig. 4 Fly Ash

IV. TESTS TO BE PERFORMED

- Scanning Electron Microscope.
- X-ray Diffractometer Analysis.
- Study of geotechnical properties.
- Determination of pH value.
- Determination of specific gravity.
- Determination of particle size analysis.
- Determination of Compaction characteristics.
- Consistency Limits Analysis.
- Determination of permeability.
- Determination of shear strength.
- Determination of California bearing ratio.
- Determination of unconfined compressive strength.
- Aggregates test.

V. CONCLUSION

This paper exhibited a review of the ongoing research on the utilization of ferrochrome slag in different civil engineering application, for example, road development, and cement and concrete industries. The examination presumed that the physical and mechanical properties of FeCr are superior to those of natural construction material total which make it appropriate material to be utilized as total substitution in cement and pavement development applications, for example, in rigid and flexible pavement and base or sub-base materials. Ecological effect appraisal demonstrated that FeCr slag is non-risky material and earth amicable to be utilized as a green construction material in lieu of normal construction material. Waste material is a wellspring of optional crude materials and yet can adversely affect the regular habitat and general wellbeing. The generation of mechanical side-effects in India is relied upon to increment quickly in the coming not many years because of the modern advancement in the nation which will detrimentally affect the earth except if the executive's arrangements and enactments are created. Fruitful usage of modern side-effects in the development business would require progressively point by point monetary and ecological investigations just as building plan details.

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