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Application of Micro Concrete for Repair of Concrete Pavement - A Case Study.

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Abstract

Micro-concrete is a mixture of suitably graded sand, cement and water to simulate concrete in small scale models. The cement and sand mixture in dry form are supplied in pre-packed bags. It is ready to use dry powder whichrequiresjust theadditionofwater andmixing it beforeapplication. Therequiredquantity of water is to be added for ensuring the flowability. It is formulated for use in repair works of concrete where placing of conventional concrete is difficult, repair to damaged reinforced concrete elements like beams, columns, wall etc., where access is restricted and compaction is not possible. Repair and rehabilitation of RC structures has become a common event in the field of civil engineering. This is mainly due to the quality of the materials used, poor quality of workmanship, insufficient funds and so on. Generally, the expected life of an RC structure is 100 years and now there is no such case and for repair of these RC structures, most importantly used material is concrete. This paper presents the micro concrete application in repair of concrete road pavement with reference to a case study in line with the said application.

Keywords: Micro-Concrete, RC structure, Repair and Rehabilitation

Introduction

Micro concrete is a dry ready mix cementitious based composition developed to be used in repairs of areas wherever the concrete is damaged & the realm is restricted in movement creating the placement of typical concrete troublesome[7]. It is provided as a ready to use dry powder which needs solely addition of fresh water at site to produce a free flowing non shrink repair micro concrete[4]. This is a cementitious material, with additives, that impart controlled expansion characteristics within the plastic state with reduced water demand. For the repair of damaged reinforced concrete parts like beams, columns, wall etc., wherever access is restricted and compaction isn't doable also for Jacketing of RCC columns to extend its load bearing capacity[8]. It's designed to be used in medium & massive volume repairs generally starting from 5mm to 50 mm thickness & deep[1]. The repair and rehabilitation of damaged concrete structures is quite often during a extremely aggressive atmosphere like Mumbai, related to high level of pollution, high humidness throughout the year, high rain together with higher level of chloride contents within the atmosphere[5]. Ageing of the structure and persistent use when the design lifetime of the structure also results in deterioration of the structures. There are numerous products out there in market for repair and rehabilitation however Micro concrete is most price effective for improving the high early compressive strength, tensile and flexural strength and reducing the brittle nature[5]. Micro concrete particularly latex modified concrete like styrene- butadiene, acrylic latex, polyvinyl acetate, and ethylene vinyl acetate are widely used for structural repair and strengthening. Repair to damaged reinforced concrete parts like beams, columns, wall etc., wherever access is restricted and compaction isn't attainable and for structural strengthening by Jacketing of R.C.C. columns to extend load carrying capability are areas of application of micro concrete[1]. Due to its self-flowable nature it can also be

placed wherever reinforcement is congested, compaction isn't possible and in places wherever human access in restricted[4]. Application to structural parts is extremely simple because of its flow nature and finished surface quality is smooth in comparison with standard concrete[8].

Theory

Micro concrete is combination of cement, high quality graded fine aggregate, shrinkage compensating agents and dispersion agents in powder type marketed as dry powder in packets by construction chemical corporations[2]. This can be mixed with pre-determined quantity of water depending on the consistency wanted - trowelable or pourable. It is applied as repair mortar or to fill the crevices that cannot be done by standard concrete. Micro concrete is a dry prepared combined building material developed to be used in repair of areas wherever the concrete is damaged & the realm is restricted in movement creating the placement of standard concrete troublesome[7]. It is provided as a ready to use dry powder which needs solely addition of fresh water at site to provide a free flowing non shrink repair concrete. Micro concrete is a cementitious building material, with additives, that impart controlled enlargement characteristics within the plastic state with reduced water demand[7]. Higher thickness could also be accomplishable depending on the configuration of the repair location and also the volume of exposed reinforcing steel thereby providing the ultimate formulation[2].

Literature review

Ahmed Hussain (2017)[1] studied the effectiveness of an alternative technique involving micro-concreting (around square specimen to obtain circular) for increasing existing column capacity without much increase in section dimensions under axial compressive load using 200 T compression testing machine.

Burak Felekoglu (2014)[2] has been studied and compared the advanced rheological properties of micro-concretes and cement pastes.

C. Jayasinghe et. al (2006)[3] has carried out a comprehensive study on strength and durability aspects of Micro Concrete Roofing (MCR) tile along with the cost analysis.

Dr. R. Vijayalakshmi et. al (2017)[4] has discussed about the performance of concretes used in repair and rehabilitation scenarios namely Self-Compacting Concrete (SCC) and Micro concrete.

Jonbi Jonbi et. al (2018)[5] has carried out the experimental study on modified micro concrete material by adding Polycarboxylate Ether (PCE) and Polypropylene Fibre (PPF) at the time of mixing existing rapid setting materials.

K. Naga Rajesh et. al (2019)[6] reviewed the usage of sustainable materials (SM) in the production of micro-concrete and some of the effects of utilization of these SM in micro-concrete.

Mukesh Choudhary et. al(2016)[7] discussed the detail investigation between repair methodologies i.e. polymer modified mortar and micro concrete which helps in understanding the feasibility of each method, such as strength gain, cost comparison, durability, extension of life of member etc.

Saim Raza et. al (2019)[8]has discussed the various strengthening and repair methods for RC columns proposed by researchers in the last two decades and also identifies potential research gaps and outlines the future direction of research into the strengthening and repair of RC columns.

Case Study

In India, new roads are being constructed rapidly and existing arteries are increasingly being expanded[5]. However, once roads are built, they often undergo structural damages. The roads in metro cities such as Mumbai, Delhi, Kolkata, etc. carries heavy traffic and a high volume of vehicles. Contours of the highway that climb sharply and turn abruptly, combined with unstable base soil factors and high amounts of rainfall, result in rapid erosion and other soil issues that cause damage to the road bed and pavement surfaces, including collapsing, pumping, and spalling, as illustratedin the following figures[5].

a b

Fig 1. (a-b): Damage to the concrete pavement

One of the main obstacles to perform effective repairs is the requirement that these important roads should not be closed for very long during the repair process.[5] In addition, although high-early-strength cementitious repair materials are commercially available, many of these materials are especially vulnerable to cracking, poor bonding, and premature deterioration, which result from various causes such as incompatibility with the existing concrete pavement. Satisfactory repair work requires materials with rapid setting criteria that have high compressive strength and flexure strength[5]. These important characteristics ensure longer service life. Long service life means fewer future repairs as well as longer intervals between rehabilitation and reconstruction projects, leading to significant savings in both the quantity of pavement materials required and overall expenditures. Some studies have shown there have been issues arising when using high-early-strength concrete in repair applications for pavements. Therefore, it is essential that good-quality materials which have the structural capabilities to confirm to or even exceed the standard criteria for such repairs should be developed as quickly as possible.

In accordance with the above requirement for repairing of the concrete road pavement, following case study has been studied.

The repair work has been carried out on the concrete road at Powai near S. M Shetty School on which cracks have been developed. Contractor involved was Navdeep Construction Company. The thickness of pavement was 300 mm.

For repairing of the road following mix proportion was done as shown in table 01.

Table 01: Mix proportion

Cement	OPC – 460 kg/m^3
Fly ash	160 kg/m^3
Micro silica	35 kg/m^3
Crushed sand	837 kg/m^3
Coarse aggregate (10 mm down)	804 kg/m^3
Water	170 kg/m^3
w/c ratio	0.26
Agg/c ratio	2.51
PCE	0.65 %
SBR polymer (Monobond Krishnaconchem)	5% of the total cementitious content

Methodology

Method of application and mixing of the micro concrete for repair of concrete road pavement done at the site is as summarizedbelow:

Step 1: Surface preparation:
A) Making the groove
B) Cleaning the application surface
Step 2: Mixing the contents

Step 3: Application of the material prepaid (Micro concrete)

Fig 01: Making the groove

Fig 02: Cleaning the application surface

Fig 03: Mixing the contents

Fig 04: Applicaton of material prepared

Step 1: Surface preparation:
Surface preparation refers to the pre preparation work of the application area for effective work. As in the mentioned case study, surface preparation was carried out as under:

A) Making the groove:
The Crack which was developed has been opened properly by cutting the V shaped grove so that the repair work to be carried out would result in a good way.

B) Cleaning the application surface:
The grooved surface was then prepared before the application of micro concrete by removing oil, bond inhibiting agents, dirt, dust and laitance. The cleaning can be carried out with suitable methods like usingwire brush, water jetting, mopping, etc.

Step 2: Mixing the contents:
All the ingredients as per mix proportion was then mixed to the measured quantity of water with constant stirring. It was mixed to a thick lump free consistency and allowed to stand for 2 minutes for the mix to mature and then remixed to use.

Step 3: Application of the material prepaid (micro concrete):
The mixed material was applied to the preparedsubstrateusingthe appropriatepouringfunnels and chutes. It should not be vibrated with any mechanical vibrators as it is self-compacting by itself and any external vibrationwould segregate the mix.

Test results:

Final setting time – 50 minutes Flexural strength @ 7 days – 5.1 MPa

Summary

From the above case study and subsequent test results from the same, it can be summarized that micro concrete can also be used for the repairs of concrete road pavements.

Conclusions

In this paper, setting time plays a vital role with respect to the referred case study on the application of micro concrete for the repair of concrete road pavement. Setting time is an important factor for cost- effective rigid pavement repairs, because reducing total work time (and road usage down time) is critical when concrete road repairs are involved.

Hence, based on the above observations on setting time, referred technical papers on various applications of micro concrete and specific case study related to the application of micro concrete for the repair of structural cracks in the rigid concrete road pavement, it can be concluded that apart from the normal applications of the micro concrete being used for strengthening of columns, beams, foundations, etc., it can be also considered for the repairs of concrete road pavement. Thus, the use of this micro concrete material has been found to be viable for future repairs of heavily trafficked roads.

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