International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 5 Issue 6, September-October 2021 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Impact of Waste Engine Oil and Fly Ash on Concrete Composition and Engineering Properties

Anil[1], Sunil Kumar[2]

[1]M.Tech Scholar, [2]Assistant Professor,
[1,2]Jan Nayak Chaudhary Devi Lal Memorial College of Engineering, Sirsa, Haryana, India

ABSTRACT
Construction Industry is accelerating day-by-day, which results in increasing demand of basic civil engineering material i.e. cement. Engineers are looking for alternative of expensive construction since long. Cement, binder in concrete, is an expensive and exorbitant civil engineering material and it increases the Constructional budget. Not only this, but also cement marks the highest consumption throughout the world after water. The carbon credits to the environment during cement production, is an alarming issue. If it keeps following the exact pace as today, it is probable to reach annual cement production up to about 600 metric tones by 2025 in India alone and the globe will change into hot air balloon. Cement industry alone contribute to 2.4% to the total carbon emissions round the globe. Present research is an approach to relieve some burden of environment and construction industry as well. This research is aimed to achieve these objectives- To understand the characteristic features of waste engine oil (WEO) and fly ash (FA), to investigate impact of incorporation of WEO and FA on engineering properties of green and hardened concrete and to find the optimum content of FA & WEO to form the modified concrete mix with improved properties. Content of additives i.e Fly ash and WEO in present investigation as a substitute of cement is 30,40 & 50% and 0.5, 0.75 & 1% resp. The properties like workability, air content and porosity were improved by the addition of FA + UEO, but compressive strength is adversely affected. So, for FA content of 40% and UEO content of 0.5% showed the optimum properties by least decline in compressive strength. Along with these quantitative results from experiments, other inferences are made qualitatively and it is forthcoming that segregation, bleeding and effect of freeze thaw cycles are extremely diminished with this proposed modification.

How to cite this paper: Anil | Sunil Kumar "Impact of Waste Engine Oil and Fly Ash on Concrete Composition and Engineering Properties" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-5 | Issue-6, October 2021, pp.1200-1206, URL: www.ijtsrd.com/papers/ijtsrd47614.pdf

IJTSRD47614

Copyright © 2021 by author (s) and International Journal of Trend in Scientific Research and Development Journal. This is an Open Access article distributed under the terms of the Creative Commons Attribution License (CC BY 4.0) (http://creativecommons.org/licenses/by/4.0)

1. INTRODUCTION

Construction Industry is accelerating day-by-day. Today is the scenario of sky scrapping and complex infrastructures, which results in increasing demand of basic civil engineering material i.e. cement. Engineers are looking for alternative of expensive construction since long. Cement, binder in concrete, is an expensive and exorbitant civil engineering material and it increases the Constructional budget. Not only this, but also cement marks the highest consumption throughout the world after water. The carbon credits to the environment during cement production, is an alarming issue. If it keeps following the exact pace as today, it is probable to reach annual cement production up to about 600 metric tones by 2025 in India alone and the globe will change into hot air balloon. Cement industry alone contribute to 2.4% to the total carbon emissions round the globe.

To eradicate this converse effect of cement industry on the environment, engineers are working hard to find efficient substitutes which are in-expensive, eco-friendly and can possess better cementing properties. Agricultural and commercial wastes are the best choice and have the characteristics favoring their utilization in concrete production. These by-products are complete waste and if re-used in any sort releases a huge burden from environment.

Fly-ash (FA) and Used/Waste Engine oil (UEO/WEO) are used in the current investigation to partially substitute cement in concrete production. Properties and potential of WEO and FA are investigated in the present work. The major concerns are porosity, workability, air content and Compressive strength. The new modified concrete, produced from optimal blend of FA+WEO in other general ingredients of concrete viz. Cement, fines and coarse aggregates, is tested for these ibid properties and compared the same of conventional concrete.

2. Literature review

Shafiq Nasir et al (2021) they discussed in length, in their investigation that any sort of waste products generated by Industries, residences and agricultural waste is hazardous to environment. Also it is very hard to dispose-off these wastes, as practice of disposal of waste in compliance to strict disposal regulations of Municipal Corporation is very expensive. They noticed the trickling of engine oil of old grinding units of certain cement industry. This oil inadvertently mixes with cement during grinding of clinker. The concrete produced through this cement has similar behavior as that of air-entrained concrete. This modified concrete had good freeze and thaw resistance. This was their only hypothetical theory as it is not backed by any strong evidence of past practice. They conducted their investigation to validate their proposal and tested the properties of green concrete and hardened concrete. In preparation of samples they used varying dosage of "SIKA AER" air-entraining agent, used engine oil and new engine oil. Major concerns of their investigation were workability and air content. Both of these properties were enhanced to highest by used engine oil as compared to new engine oil and air entraining agent. From the results it was inferred that slump value increased to 38% and value of air content hiked to about 58%.

Ali Mohammad Okashah et al (2020) in their research proposed an easy alternative to disposal of UEO and Silica Fume (SF). Both SF & UEO are industrial wastes and are a cause of environmental disparagement. The burdensome way of their disposal can be relieved safely and smartly by applying both the waste products in modification of concrete. Properties of both green as well as hardened concrete are improved by their implications. They used SF as partial substitute of cement and UEO as an additive. The content of cement replaced by SF was 10 to 15% and the content of additive i.e UEO ranges between 0.6 to 0.8%. From various experimentations they sought to a conclusion that 15% SF content and 0.6% UEO improved the strength of concrete in compression by 37% without harming any other properties.

Trino Baloa Montilla et al (2019) in their work suggested a better method of utilization of Automotive Residual Oil (ARO). The main aim of their investigation was to eradicate preeminent problem of society of ARO, because only a liter of ARO can contaminate million liters of pure potable water. Not only this but also if this water is used to irrigate crops, it will make the soil unproductive and the water seeps into ground and contaminates the ground water. They studied in their work physical as well as engineering properties of concrete. The content of ARO ranges between 0.10% and 0.80% by wt. of cement. The modified concrete specimens with varying dosage of ARO underwent a detailed experimental program comprising compression test, tensile test, UPV (ultrasonic pulse velocity) test, absorption and adhesion test. From this experimental program it was inferred that the ARO content ranging between 0.10% and 0.30% gave consistent results in all the tests. But the optimum content suggested by them was 0.14%. They recommended this mix probably for pavements and places where heavy impact resistance and superior structural features are required.

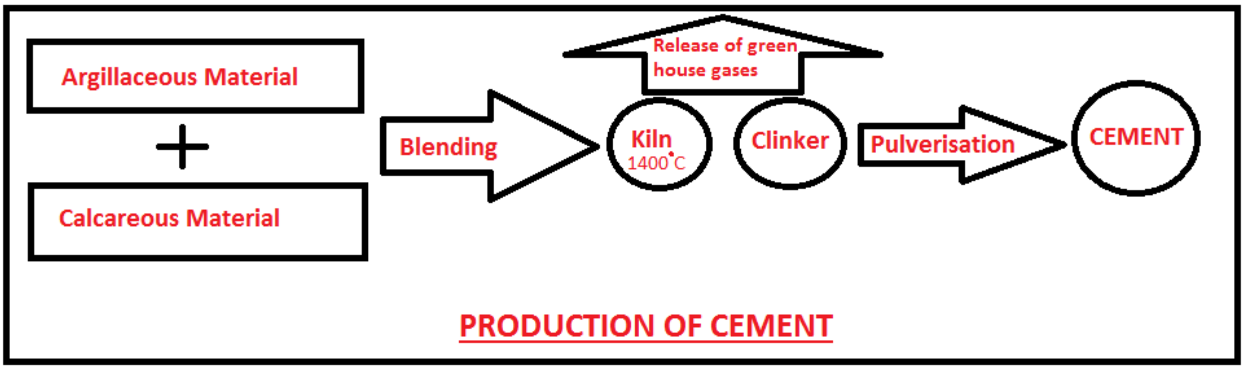
Salahaldein Alsadey (2018) in his paper accentuated certain engineering properties of concrete blended with waste engine oil as a chemical admixture. He investigated experimentally the workability and load bearing properties of concrete blended with waste engine oil as chemical additive/admixture into the conventional control mix. This effort resulted in evolution of conservational technique of dumping discarded oil. This effort of his eases the disposal of oil, as the prevailing regulations of waste disposal are very stringent.

Four different composition of oil UEO were used viz. 0.6, 0.8, 1.0 and 1.2% by wt. of cement. These specimens were tested for workability and compressive strength. From the results of ibid tests it was inferred that there found a significant improvement in workability and a trivial decline in compressive strength.

Abdullah Anwar et al (2014) in their work investigated and explored the potential of fly ash as a partial substitute of cement. They used a high content of fly ash i.e. up to 30% to replace cement. They suggested better way to replace cement with a prior material which is available at free of cost and improves strength of concrete. As per the justification proposed by their investigation the strength of cement increases as the proportion of water and binder is reduced which is due to the fact that the proportion of water and binder is reduced due to addition of fly ash.

3. Material Used

Cement: Inorganic binding material in concrete mix is known as cement the most commonly used cement is called Portland cement. When it is mixed with water, it hardens; hence it is called hydraulic cement. Materials mainly present in cement are oxides of calcium, silicon oxide, aluminum oxide, iron oxide and alkalis, etc. the raw materials are limestone and clay or minerals, which are rich in lime, and rich in silica and alumina, these material are burnt together at a temperature of 1400 degree Celsius or so to form what is known as clinker, which is nothing but a solid solution of these minerals forming cement compounds. Clinker is grinded further and mixed with a little bit of gypsum, of the order around 5% gypsum to control the setting properties.



Production of Cement

Production of cement is as harmful for ecosystem as it is beneficial for construction industry. The main harm is emission of greenhouse gases in ample during production of cement.

Collection of cement: Cement used in present investigation is Ultratech cement OPC43 and it is collected from my vicinity where construction of a residential building was under process. The cement was primarily tested in field by two methods:

- It was rubbed between fingers and thumb of hand and it felt smooth, so this cement was fine to use and free from impurities
- It was tested for float test, a hand-ful of cement is dropped in a bucket containing some water. The cement sunk in the water completely, so it is fine.

Waste engine oil: Lubricants find their implications in transmission, insulation, greasing, etc. these lubricants or engine oils are partly used in various processes of engine, rest part is a complete waste. This is due to the fact that no engine oil can work ideally in real situation to give 100% efficiency, how small may be the quantity of waste engine oil, but still there is wastage

But the waste engine oil got contaminated with other substances like dust, rust, water, lead, metal particles, carbon, or other by-product of combustion process. This waste engine oil if disposed of directly into drains or on ground then it may penetrate underneath the ground and can interfere with the ground water 1ml of engine oil can contaminate 100 L of pure water and about 43 square feet land. The contaminants like lead, chromium, arsenic, biphenyls, zinc, cadmium, magnesium, etc turn a highly productive land into a barren land.

As we all know water pollution has become the biggest issue of 21st century. Among all pollutants of water the worst is oil. Every year tons of oils from various sources are dumped into water body which not only destroy the eco system of water but makes the water unsuitable for any productive purpose. Something must be done so as to prevent this water pollution, as water is primary source for subsistence of life. This investigation is an afford to provide easy and inexpensive safe disposal of engine oil to prevent water pollution terms of oil spills in oceans and seas through cruises and ferries. For cleaning the seas and to avoid any miss happening this oil must be reclaimed. After reclamation, there came the problem of disposal. This oil can safely be used in concrete production. This modified concrete has improved properties then conventional concrete.

Fly Ash: Combustion of any solid material results in production of ash. Thermal power plants use coal as fuel to heat the water in boiler to generate steam from water. This steam in turn runs the turbines to generate electricity. But from burning of coal the residue left is a pulverized ash generally termed as “Fly ash”. It is very light weighted and it can rise with gases this is the reason it is called Fly ash. Electrostatic precipitator collects the fly ash from gas flowing out of chimney. 73% of total power production is catered by thermal power plant, and 90% of thermal power stations run of coal as a fuel. Today 60% of total fly ash produced in India is used by the construction industry in partial replacement of cement, but the target is to use 100% fly ash, so as to revert positive effect to environment.

ASTM C-618 categorized fly ash in two classes viz. Class C and Class F. this categorization is basically on the basis of type of coal. CaO content varies from coal to coal. Antracite or bituminous coal produces Class F fly ash whereas Class C fly ash is generally obtained from burning of sub-bituminous or lignite coal. In thermal power stations bituminous coal is used for generation of electricity, and these produce Class F fly ash. Class C fly ashes are rich in Cao content, so can be used as cement itself than as SCM. [Supplementary Cementing Material (SCM): It is any material that when used in combination with Portland cement contributes to the properties of hardened concrete through hydraulic or pozzolanic activity or both.]

Collection of fly ash: Fly ash for present research work is collected from Rajiv Gandhi Thermal Power Station, Khedar (a village near Barwala) in Hisar district of Haryana, India. The Fly ash is Class F fly ash and possesses the following properties as tabulated below:

4. Methodology & Experimentations

For various experimentations 13 samples were prepared by the mix design. The samples were as follows:

- Specimen No:1- Conventional Control Mix (CM)
- Specimen No:2- CM + 30% FA
- Specimen No:3- CM + 40% FA
- Specimen No:4- CM + 50% FA
- Specimen No:5- CM + 30% FA + 0.5% UEO
- Specimen No:6- CM + 30% FA + 0.75% UEO
- Specimen No:7- CM + 30% FA + 1.0% UEO
- Specimen No:8- CM + 40% FA + 0.5% UEO
- Specimen No:9- CM + 40% FA + 0.75% UEO
- Specimen No:10- CM + 40% FA + 1.0% UEO
- Specimen No:11- CM + 50% FA + 0.5% UEO
- Specimen No:12- CM + 50% FA + 0.75% UEO
- Specimen No:13- CM + 50% FA + 1.0% UEO

The mix proportions as detailed above are tabulated in table below, were chosen for validation of current investigation.

Mix Proportions of specimens prepared

Mix	Cement OPC 43 (Kg/m^3)	FA Kg per cubic meter	Fine aggregate Kg per cubic meter	Coarse aggregate Kg per cubic meter	Water Kg per cubic meter	UEO (%)
CM	450	0	560	1250	162	0
CM + 30% FA	315	135	560	1250	162	0
CM + 40% FA	270	180	560	1250	162	0
CM + 50% FA	225	225	560	1250	162	0
CM + 30% FA + 0.5% UEO	315	135	560	1250	162	0.5
CM + 40% FA + 0.5% UEO	270	180	560	1250	162	0.5
CM + 50% FA + 0.5% UEO	225	225	560	1250	162	0.5
CM + 30% FA + 0.75% UEO	315	135	560	1250	162	0.75
CM + 40% FA + 0.75% UEO	270	180	560	1250	162	0.75
CM + 50% FA + 0.75% UEO	225	225	560	1250	162	0.75
CM + 30% FA + 1.0% UEO	315	135	560	1250	162	1.0
CM + 40% FA + 1.0% UEO	270	180	560	1250	162	1.0
CM + 50% FA + 1.0% UEO	225	225	560	1250	162	1.0

Experimentations: The above 13 specimens are prepared for validation of the present research work. This modification is validated by detailed experimental program on both green as well as hardened concrete. These tests are listed as below:

Tests conducted on green concrete
- Slump Value Test
- Air Content Test

Tests conducted on hardened concrete

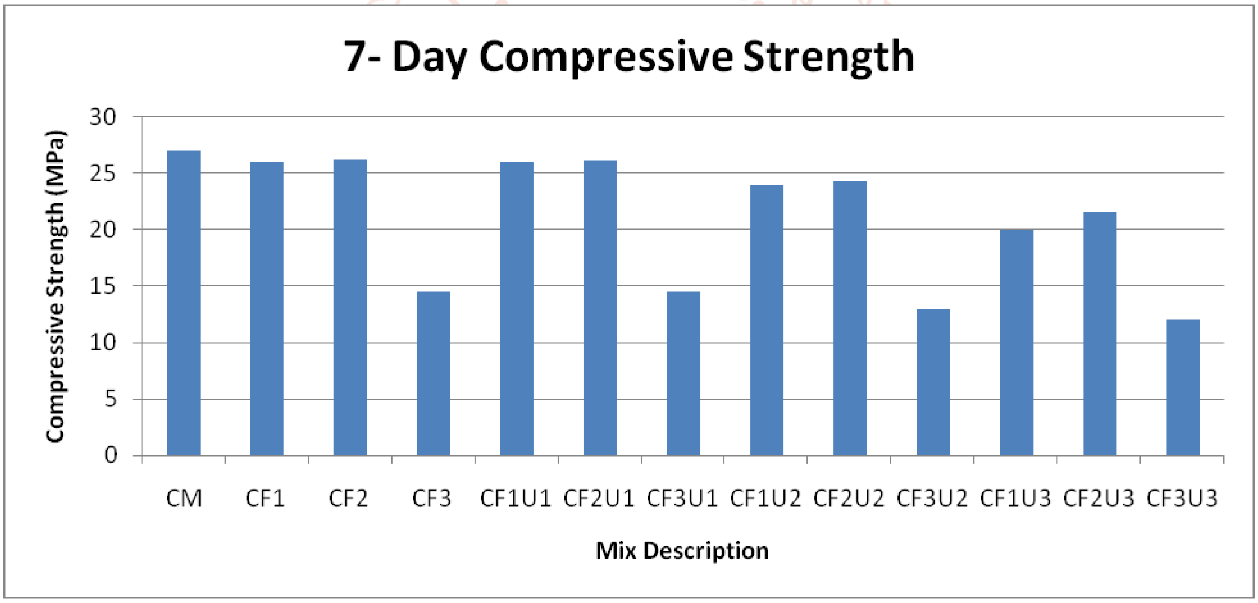
- Compressive Strength Test
- Test for Porosity

5. Results and Discussion

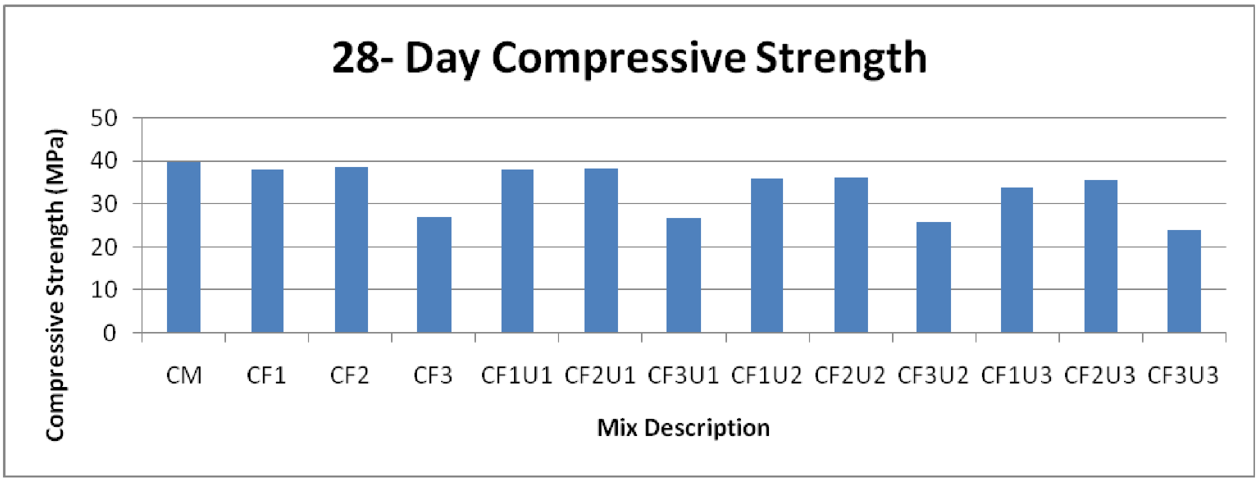
Compressive Strength Test: This test is carried out to ascertain the Compressive strength of different mixes. The results are tabulated in table below and results from table are compared in the preceding bar graph:

Result of compressive strength test

Mix Description	Designation	Compressive Strength after 7 days MPa	Compressive Strength after 28 days MPa
CM	CM	27	40
CM + 30% FA	CF_1	26	38
CM + 40% FA	CF_2	26.2	38.6
CM + 50% FA	CF_3	14.5	27
CM + 30% FA + 0.5% UEO	CF_1U_1	26	38
CM + 40% FA + 0.5% UEO	CF_2U_1	26.1	38.5
CM + 50% FA + 0.5% UEO	CF_3U_1	14.5	26.8
CM + 30% FA + 0.75% UEO	CF_1U_2	24	36
CM + 40% FA + 0.75% UEO	CF_2U_2	24.3	36.4
CM + 50% FA + 0.75% UEO	CF_3U_2	13	26
CM + 30% FA + 1.0% UEO	CF_1U_3	20	34
CM + 40% FA + 1.0% UEO	CF_2U_3	21.6	35.8
CM + 50% FA + 1.0% UEO	CF_3U_3	12.1	24.2



Comparison of 7-Day Compressive Strength



Comparison of 7-Day Compressive Strength

Discussion on Compressive Test: The Compressive strength value of conventional concrete marked 27 MPa and 40 MPa after 7 days and 28 days respectively, with addition of fly ash there seen an insignificant decrease in Compressive strength value. Also with combination of FA and UEO the values of compressive strength declines continuously with increase in content of FA and WEO.

6. Conclusion & Future Scope

Based on detailed experimental program and discussion of results, following conclusions can be made:-

- Disposal of waste product is a burdensome job due to stringent restrictions of waste disposal rules. So, finding alternative use of wastes then dumping them off is better. FA and UEO are two waste products and these can be re-used in concrete production.
- Incorporation of FA and WEO blend in concrete improved the workability of concrete. The slump value of conventional concrete marked 25mm with addition of fly ash there seen an insignificant increase in slump value. But with combination of FA and UEO the values of slump are significantly improved and almost doubled in case of 1% content of WEO + 50% FA. This is due to the fact lubricating effect of WEO increases the fluidity of concrete.
- The value of air content for conventional concrete marked 1.8% with addition of fly ash there seen a significant increase in air content. But with combination of FA and UEO the values of air content are significantly decreased. Thus the mix with UEO and FA has more resistance to repeated freeze and thaw cycles, where exposed to extreme weather.
- The Compressive strength value of conventional concrete marked 27 MPa and 40 MPa after 7 days and 28 days respectively, with addition of fly ash there seen an insignificant decrease in Compressive strength value. Also with combination of FA and UEO the values of compressive strength declines continuously with increase in content of FA and WEO.
- The porosity of conventional concrete marked 10.2% after 28 days with addition of fly ash there seen an insignificant decline in porosity. But with combination of FA and UEO the values of porosity are significantly reduced. This is due to the fact lubricating effect of WEO reduces air voids thus reducing the porosity.

Thus to sum up the properties like workability, air content and porosity were improved by the addition of FA + UEO, but compressive strength is adversely affected. So, for FA content of 40% and UEO content of 0.5% showed the optimum properties by least decline in compressive strength. Along with these quantitative results from experiments, other inferences are made qualitatively and it is forthcoming that segregation, bleeding and effect of freeze thaw cycles is extremely diminished with this proposed modification.

Future Scope: The un-deniable fact of universe “No one can explore everything”. There are yet miles to go in this regard. Some of the further advancements and works, which may be started, for which this research may serve as background, are as follows.

- A more detailed exploration of properties of UEO and FA blends in structural elements like columns, pavements, etc.
- The usage of UEO in modification of asphaltic mix in flexible pavement may be explored.
- This research work includes only four tests of engineering properties other test may be paid heed.
- This exploration used limited contents of both the materials, other percentage contents may be explored
- This research used only two waste materials, potential of other prevalent wastes can also be explored

7. References

[1] NasirShafiq, MuhdFadhilNuruddin and Ibrahim Kamaruddin, "Effectiveness of used engine oil on improvement of Properties of fresh and hardened concrete", Proceedings of the Asia-Pacific structural Engineering and construction conference, (APSEC-2006), 5-6 Sep2006, Kaula Lumpur, Malasia.

[2] Dr. ShathaSadiqHussen, "Using of Industrial Waste as a Green Chemical Admixture in Concrete", Kufa Journal of Engineering, Vol-7, NO-1, Jan 2016, pp 104- 114.

[3] Mohammed Noori Hussein, “Properties of Concrete Containing New and Used Engines Oil”,International Journal of Science and Research (IJSR) ISSN (Online): 2319-7064, Volume 4 Issue 12, December 2015, pp 268-272

[4] HeshamDiab,” Effect of Mineral Oil on Reinforced Concrete Structures part-1, Deterioration of Compressive Strength”, Journal of Engineering Sciences, Assiut

University, Vol. 39, No 6, pp.1321-1333, November 2011

[5] NasirShafiq, MuhdFadhilNuruddin and Ibrahim Kamaruddin; Effectiveness of used engine oil on improvement of properties of fresh and hardened concrete", Proceedings of the 6th Asia Pacific Structural Engineering and Construction Conference, 2006, Kuala Lumpur, Malaysia, pp: 150 – 166.ASTM C231; American standards for testing of materials, measurement of air content in fresh concrete

[6] M. El-Fadel and R. Khoury, "Strategies for vehicle waste-oil management: a case study; Resources, Conservation and Recycling".

[7] Falahi-Ardakani, "Contamination of environment with heavy metals emitted from automotives"; Ecotoxicology and Environmental Safety, Volume 8, Issue 2, April 1984, p. 152-161.

IJTSRD
International Journal of Trend in Scientific Research and Development
ISSN: 2456-6470