Effect of Used Cooking Oil on Mechanical Properties of Self Compacting Concrete In M20 Grade

A Satya Bhairavi[1] and Dr. V Mallikarjuna Reddy[2]
M.Tech Student, Department of Civil Engineering, GRIET, Hyderabad [1]
Professor & Head, Department of Civil Engineering, GRIET, Hyderabad [2]

Abstract – Now a day's industrial wastes like solid or liquid based chemicals have been rapidly increased across the world.Used cooking oil(UCO) is one of the liquid waste.This waste is disposed into water bodies and sewage systems which effects our eco system.In this project we use UCO as an admixture to the cement binder. The objectives of this research are to know the effect of used cooking on mechanical properties of self compacting concrete in M20 grade. The obtained result shows that used cooking oil gives progressive effects of all the properties presented in this project. It increases workability and improves the mechanical properties like compressive strength, split tensile strength and flexural strength than the conventional concrete. 0.25%, 0.5%, 1% and 1.5% used cooking oil is added to the concrete. The used cooking oil obtains the optimum contribution to the concrete mix proportion of containing used cooking oil of 1.5% from the cement content. We got positive results by adding used cooking oil.

Index Terms – Used cooking oil, slump flow, compressive streng th, split tensile and flexural strength

1. INTRODUCTION

We live in a country replete with contradictions in almost all aspects. Consider poverty and rampant food insecurity that most households have to live with in India. On the other side is the huge consumption of vegetable oils, ghee, palm oil etc., in our kitchens. And this consumption continues to steadily rise with time.

Trade sources comment that the food service market has been growing at a rapid average rate of around 7 percent per annum over the past five years. They indicated that this market is likely to grow at between 7 percent and 10 percent per annum over the next three to five years. Used cooking oil will increase the loading in water treatment plant process. Is required higher amount of energy to treat the waste water. One of the most popular solutions nowadays is by recycling the used cooking oil and converts it.

The effects of used oil in cement has been conducted using a few types oil used oil such as used engine oil, soy bean, and waste paint. Research conducted by by Salmia et al. stated that used engine oil (UEO) was presented as admixture in concrete. Addition with certain amount of used cooking oil will improve the performance of the concrete either hardened concrete or fresh concrete. The used engine oil greater the fluidity of fresh concrete, increase air content and slump value, decrease the porosity of concrete. It can enhance high compressive strength and reduce the permeability to the coefficient of oxygen permeability of the concrete. Beside that, the concretes porosity and permeability can be also decreased by adding the UEO as admixturewithout affected the compression strength of concrete and supported by Hamad et al. the research on Used engine oil was implemented to determine the optimum percentage of UEO that can be utilized in MIRHA and SF concrete as compared to superplasticizer. Chin et al. also stated that the use of 0.15% of used engine oil in ordinary Portland cement concrete increase air content in the range of 40-63% compared to control mix and superplasticizer mix. Moreover, the air content of concrete with 20% replacement of fly ash (0.15% UEO) was almost similar to superplasticizer mix with the same percentage.

In Malaysia, there are companies which have a valid recognized license to collect the used cooking oil from community and processed the oil into biodiesel. Previous research was reported that used oil such as used engine oil and soy bean oil were having a potential to act as concrete admixture to improve concrete performance. According to Beddu, a certain dosage of used engine oil can improve the fresh and hardened properties of various types of concrete. In the other hand, their performance of used engine oil in concrete containing fly ash (FA) and Microwave incinerated Rice Husk Ash (MIRHA) did not impart any negative effects and comparable with commercially available superplasticizer Bilal et. al have studied the effects of used engine oil on fresh and hardened properties and also structural performance of concrete and it gave the positive effects comparable with the available commercially air entraining agent. Used engine oil also suggested by Animesh and Aravind to be use in highway construction but need well organized oil collection system. The further research is noteworthy to produce the good quality and performance of concrete. The effects of soybean as a curing agent for concrete pavement have been done.

2. MATERIALS

2.1 Ordinary Portland Cement

Ordinary Portland cement was used in this research, in accordance to BS EN 197-1 2000. OPC was preferred because the observation on concrete properties can be done in normal hydration process.

2.2 Coarse Aggregate

It is a stone or uncrushed gravel which is the result of natural disintegration and crushed gravel or stone are usually called the "Coarse Aggregates". Coarse aggregates are stones that are retained on 4.75mm sieve. Nearly all natural aggregates originate from bed rocks. There are three kinds of rocks, namely, igneous, sedimentary and metamorphic. In such, many properties of aggregate depend on the properties of the parent rock itself. In this research 10mm size aggregate is used.

Shape of three dimensional irregular bodies as coarse aggregate is difficult to describe; but is the vital property affecting the workability of fresh concrete and also its strength and durability. The characteristic of parent rock from which coarse aggregates have been produced and also the type of crusher used for crushing influence the shape of coarse aggregates. Rounded, Angular, Flaky, Elongated and Irregular are some types on shapes of coarse aggregates. Rounded particles are fully water-worn or completely shaped by attrition. Angular particles possess well-defined edges formed at the intersection of roughly planar faces. Flaky particles have thickness small relative to the other two dimensions. Elongated particles are usually angular of which the length is considerably larger than the other two dimensions. Irregular particles are naturally irregular, partly shaped by attrition and having rounded edges.

2.3 Fine aggregate

Fine aggregates generally consist of natural sand or crushed stone with most particles passing through a 9.5mm sieve. Fine aggregate is natural sand which has been washed and sieved to remove particles larger than 5 mm. in this research we used river sand. The code to be referred to understand the specification for fine aggregates is**:** IS 383:1970.

2.4 Fly ash

Fly ash is a residue left from burning coal, which is collected on an electrostatic precipitator.

2.5 Water

The water used in this research is free from impurities and chemicals is used to mix the concrete as per IS: 456:2000.

2.6 Super Plasticizer

In this research Super plasticizer is GLENIUM B233 of Fosroc chemical India Ltd. Which is used as water reducing admixture, and increases workability.

2.7 Used Cooking Oil

Oil which is used in the project is Used cooking oil. Taken from road side shop.

3. SELF COMPACTING CONCRETE

Self-compacting concrete means it is a special type of concrete that can be compacted to every corner of the formwork, purely by means of its own self-weight and without the need for vibrating or compaction. Scc is self-compacting itself alone due to its own self weight and it is characterized by high segregation resistance. The need for self compacting concrete is particularly because conventional concrete tends to present a problem with regard to inadequate consolidation in thin sections or areas of congested reinforcements, which leads to a larger volume of entrapped air and compromises the strength and durability of concrete.
SCC is a high-performance concrete which is highly flowable that can be easily placed in the tight reinforcement. It is also known as super workable concrete.Mixed proportions for self compacting concrete (M20) per cubic meter**.**
Proportions of cement: fine aggregate: coarse aggregate fly ash is 1:2.92:2.52:0.23.

Materials	M20
Cement	336 kg/m
Fine aggregate	984 kg/m
Coarse aggregate	848 kg/m
Fly ash	80 kg/m
Water	150 lt
Super plasticizer	5 lt
Viscosity modifying agent	2.69 lt
Used cooking oil	5.04

3.1 Nan-Su Method

Nan-Su proposed a simple mix design method for self-compacting concrete the amount of aggregate required is determined, and the paste of binders is then filled into voids of aggregates to ensure that the concrete thus obtained has flow ability, self-compacting ability and other desired SCC properties. By using this method mix design has been prepared.

4. EXPERIMENTAL INVESTIGATIONS

In this research two mixes are prepared, one is conventional concrete (without Used Cooking Oil) and concrete with Used Cooking oil. Mix design is prepared by using Nan-Su method.Performed workability tests like slump flow test, J-ring and L-box.

4.1 Slump flow results

From the result obtained, the slump started to increase 1.61% with addition 0.25% of UCO and 4.03% with addition of 0.5%UCO, and keep increasing 8.87%with addition 1.5% of UCO. The slump value increased compared to the control mix with addition of 1.5%UCO.

Slump flow ranges from 600 to 800 mm diameter for self compacting concrete.

Conventional	UCO 0.25%	UCO 0.5%	UCO 1%	UCO 1.5%
620mm	630mm	645mm	650mm	675mm

4.2 J-ring

The diameter of the ring of vertical bars is 300mm, and the height 100 mm.

The concrete needed is about 6 litres to perform this test. Apply the grease to the base plate and inside of the slump cone. Now place the base plate on levelled ground, after that on top of the base plate place the J-ring at the centre and slump-cone centrally inside the J-ring, hold down firmly. Fill the concrete inside the cone with help of scoop. Take the excess concrete from the top of the cone or strike off the excess concrete with the trowel. Now the cone has to be raised vertically straight without any disturbance and allow the concrete to flow freely. Measure the final diameter of the concrete in two perpendicular directions. Calculate the average of the two measured diameters. (in mm). take the difference in height between the concrete just inside the bars and that just outside the bars by measuring. Take the average of the difference in height at four locations and calculate (in mm). Note any border of mortar or cement paste without coarse aggregate at the edge.

These are the results for the J-ring after conducting the experiment.

Conventional concrete	3 secs
0.25% uco	2.5secs
0.5% uco	2 secs
1% uco	1 sec
1.5% uco	1 sec

4.3 L-box test

This test, is based on a Japanese design for underwater concrete, has been described by Peterson. The test evaluates concrete flow, and also the extent to which it is subject to blocking by reinforcement. For L-box the apparatus contains of a rectangular-section box, the shape of the box is 'L' shape, it is shown in b elow, with a vertical and horizontal l section, which is separated by a moveable gate, in front of which vertical lengths of reinforcement bar are fitted. The concrete is filled in the vertical section, and then the gate lifted to let the concrete flow into the horizontal section. After that when the flow has stopped, the height of the concrete at the end of the horizontal section is stated as a proportion of that remaining in the vertical section (H2/H1in the diagram). It specifies the slope of the concrete when at rest. This is a symptom passing ability, or the degree to which the passage of concrete through the bars is restricted. In L-box the horizontal section can be marked at 200mm and 400mm from the gate and the times taken to reach these points measured. These are known as the T20 and T40 times and are symptom for the filling ability. The sections of bar can be of different diameters and spaced at different intervals: in accordance with normal reinforcement considerations, 3x the maximum aggregate size might be appropriate. The bars can be set or locate at any spacing to impose a more or less severe test of the passing ability of the concrete.

The results for L-box is given below.

	Passing ratio	Blocking ratio
conventional	0.78	0.22
UCO 0.25%	0.82	0.176
UCO 0.5%	0.85	0.15
UCO 1%	0.8	0.2
UCO1.5%	1	0

4.4 Curing

For the cube test two types of specimens either cubes of 150mmX 150mm X 150mm or 100mm X 100mm x 100mm depending upon the size of aggregate are used. Generally, for most of the works cubical moulds of size 150mm X 150mm X 150mm is used. Self-compacting concrete is poured in the mould properly, without any vibration. And the top surface of these specimen must be made even and smooth. After 24 hours these moulds are removed and specimens which are to be tested are put in water for curing. These specimens are tested by compression testing machine after 3 days, 7 days curing and 28 days curing. Load should be applied gradually till the Specimens fails. Load at the failure divided by area of specimen gives the compressive strength of concrete.

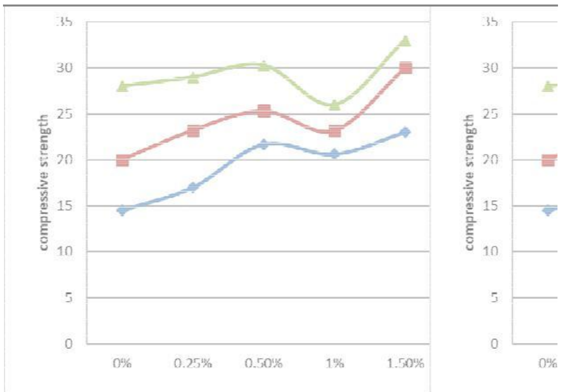
5. MECHANICAL PROPERTIES

5.1 Compressive Strength

The target mean strength is 28.25 MPa.It is observed that compressive strength increased after addition of used cooking oil, the compressive strength increase with dosage of UCO which are at 5.25%, 6.45%, 15.04% and 21.3% with 0.25%, 0.5%, 1% and 0.15% increment of UCO respectively. We got optimum at 1.5% of UCO.

Due UCO added to the weight of ceme nt Compressive strength increased compared to conventional concrete

	3 days	7 day s	28 days
Conventional concrete	17.54	19.99	29.12
0.25%	18.2	21.05	30.65
0.5%	19.55	21.78	31
1%	20.6	22.3	33.5
1.5%	21	23.55	35.33



5.2 Split Tensile Strength

The tensile strength of concrete is one of the basic and important properties splitting tens ile strength test on concrete cylinder is a method to determine the tensile strength of concrete. The concre te is very weak in tension due to its brittle nature and is not expected to resist the direct tension.

The cylinders of size 150 X 300m m is filled with concrete and set aside. The specimens ar e removed after 24 hours. Unmould the specimens a nd cylinder are placed for curing, later tested for 3 day s, 7 days and 28 days. Place the specimen horizonta lly inside the machine, and load is applied contin uously on the specimen at certain load specimens gets break. Note the value at breaking point. As we see in t he table, adding UCO the split tensile strength increas ed compared to conventional concrete

The results for split tensile strength are given below:

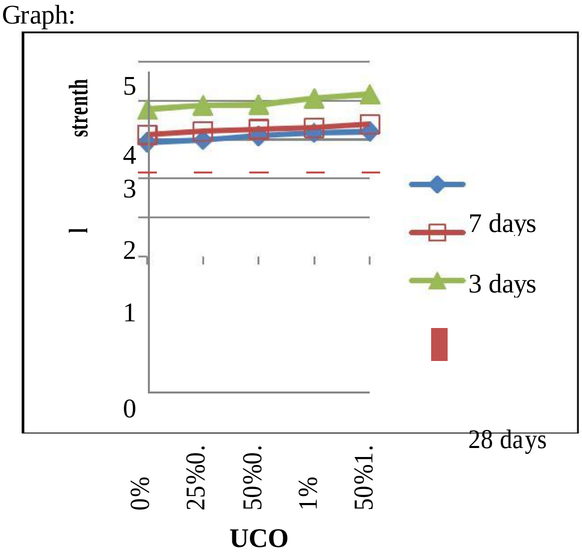
Mix	3 days	7 days	28 days
conventional	1.78	2.25	2.912
UCO 0.25%	1.782	2.305	3.065
0.5%	2.255	2.78	3.8
1%	2.46	2.63	3.65
1.5%	2.56	2.955	3.8

5.3 Flexural Strength

Flexural strength is one measure of the tensile strength of concrete. It is a measure of an unreinforced concrete beam or slab to resist failu re in bending. Beams are casted in a mould of size 100mmX100mmX500mm and kept cur ing. Later tested for 3 days, 7 days and 28 days in flexural strength testing machine and load is applied after the specimen breaks, note the load where the specimen breaks. The results are given below. Her e after adding UCO,flexural strength also increased compared to conventional concrete.

Mix 0.7√□ □	3 days	7 days	28 days
conventional	2.93	3.12	3.77
UCO 0.25%	2.98	3.211	3.87
0.5%	3.09	3.26	3.89
1%	3.17	3.30	4.05
1.5%	3.20	3.39	4.16

Graph:



6. CONCLUSION

From the experiment investi gation:

1. It is observed that the workability of concrete containing UCO i ncreased compared to conventional concrete o r controlled concrete.
2. The compressive strength of concrete increased 21% by adding UCO. It give more compressive strength compared to conventional concrete in all the ages of 3, 7 and 28 d ays.
3. Split tensile strength a nd flextural strength also increased by adding UCO to the cement binder.

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