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Aims and Scope

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Contents

Occupational Health Risks of Heavy Metal Concentrations in Kamfani Kwali Mining Wells, Bukkuyum, Nigeria

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ABSTRACT

The study is a section of research works prompted by necessity to identify occupational hazards related to chemical risks from exposure to heavy metals and other elements in mining exercises of Kamfani-Kwali artisanal Gold Mining wells. Seven mining wells were sampled for analysis. The samples collected were analyzed at Nigeria Institute of Mining and Geoscience, Jos Plateau State with the use of institute's X-ray Fluorescence machine. Thirty-six elements were analyzed. Three elements, As, Fe and Mn are found to occur at above regulatory benchmarks; Manganese occurred raised in most of the wells resulting in a maximum value of 3648.809ppm against a benchmark of 3200ppm, iron with maximum of 90138.06ppm compared to screening limit of 55000ppm while Arsenic record a whooping maximum value of 616.632ppm against limit of 22ppm non cancer rating. By application of United States Environmental protection Agency risk based guidelines, a final non –carcinogenic risk analysis indicates Arsenic with a risk-based value of 1.13E+00 resulting from three pathways of ingestion, inhalation and dermal exposures. The carcinogenic values indicates that exposure route by inhalation of Arsenic is the major probable risk pathway with a value of 2.76E-07. Based on the the overall risk-based assessment, inorganic Arsenic, the workers working in the mine wells are being exposed to immediate and latent occupational hazards that can be life threatening.

Keywords: Occupational Health Hazard, artisanal Mining, Heavy metals, XRF analysis, risk assessment, reference dose, cancer slope factors.

1. INTRODUCTION

Zamfara State has appreciable concentrations of heavy metals in its mineral -rich rocky soils. One of the notable mineral deposits in the State is Gold. Gold mining has been on for many decades, however in recent times, it becomes a widespread and very profitable endeavor. Artisanal and small-scale Mining is a means of livelihood adopted primarily in rural areas(Veiga,2003). Minerals are extracted in Artisanal and Small-Scale mining by people working with simple tools and equipment (Bradshaw, 1997). This is sometimes called informal sector, which is outside the legal and regulatory framework (Azubike, 2011). Most artisanal miners work in difficult and often very hazardous conditions in the absence of required safe mining regulation to safeguard the operations (Veiga, 2003). Apart from problems, health issues are not left out because of artisanal and small-scale gold mining operations (Ako et.al. 2014). Toxic materials are released into the environment, posing large health risk to the miners, their families and surrounding communities (Azubike, 2011). Thus, gold mining operations are particularly dangerous, as they often use mercury amalgamation process to extract gold from ores (CDC, 2001).

Fig.1 Map of Nigeria showing research area.

Despite serious dangers posed by this activity, artisanal gold mining operations continue to spread due to; rise in the demand for gold and other unattractive nature of other means of livelihoods such as farming in the rural areas where the mineral is substantially available (Akoet.al, 2014) According to Ako et.al. (2014), in March 2010, Medecins San Frontieres (MSF) discovered an epidemic of lead poisoning in Zamfara State in North-Western Nigeria particularly in Anka and Bukkuyum Local Government Areas of the state (MSF, 2010). Subsequently, investigations by the Centers for Disease Control (CDC), the World Health Organization (WHO) and the Zamfara State Ministry of Health (ZMOH) confirmed that hundreds of children under ages of five were at risk of death or serious acute and chronic health effects due to extremely high levels of lead and mercury (Abdullahi and Alhassan, 2016). At least 10,000 people were estimated to be affected overall (MSF, 2010). In majority of the developed countries the 'concerns from exposure to environmental pollutants have led to an increase in the measures taken to reduce the release of these chemicals into the environment and to protect miners and the general public (Samuel et.al., 2016), however, the third world countries, including Nigeria, are largely not abreast with the developments. This drawback can be adduced to a number of interwoven factors some of which includes ignorance, poverty level and resistance to change.

Mining activities and other geochemical processes often result in the generation of acid mine drainage (AMD) a phenomenon commonly associated with mining activities. It is generated when pyrite (FeS2) and other sulphide minerals inthe aquifer and presents and former mining sites are exposed to air and water in the presence of oxidizing bacteria, such as Thiobacillusferrooxidans, are oxidized to produce metal ions, sulphate and acidity (Ogwuegbu and Muhanga, 2005). A look at relevant equation of such reaction gives;

$$2FeS_2 + 7O_2 + 2H_2O \rightarrow 2FeSO_4 + 2H_2SO_4$$

$$2FeSO_4 + 2H_2SO_4 \rightarrow Fe_2(SO_4)_3 + SO_2 + 2H_2O$$

$$Fe2(SO_4)_3 + 2FeAsS + 9/2O_2 + 3H_2O \rightarrow 2H_3AsO_4 + 4FeSO_4 + S$$

This study was carried out at one of the historically oldest artisanal gold mining facilities in Bukkuyum local governments area of the State (Fig. 1); The objectives of this study is to determine the concentrations of heavy metals and metalloids in the soil and sediments in the area of study; to evaluate the potential cancer and non-cancer health risk to the artisanal miners due to exposure to these metals through ingestion, inhalation and dermal contact with soil/sediment in the study area; and to compare the cancer and non-cancer health risk results of this study with published carcinogenic and non-carcinogenic health risk guidance values.

2. MATERIALS AND METHODS

2.1 Sample Collection

A total of 33 samples were collected comprising of 7 soil samples from the mining caves,(which result is isolated for this particular presentation), 12 samples from milling zone and 14 samples from tailings. Global positioning system (GPS) was used to determine the location of each sampling points.

2.2 Samples Preparations and Analysis:

The soil samples collected from the mine wells were taken to the Laboratory of Mineral Resources Engineering Department of Kaduna Polytechnic, Kaduna State, Nigeria, where they were crushed and sieved separately to a tiny bits of 38µm (Kogo et al.2009). The crushed and sieved samples were next oven dried at about 1000oC to a constant weight. All the prepared samples were then taken to Nigerian Institute of Mining and Geosciences, Jos, Plateau State, Nigeria, for XRF analysis using FXL- 83358 model of XRF machine.

2.3 Concentration Calibration

A direct comparison technique between xrf instrumental response and standards of certify values with similar matrices were used to construct the calibration curve. Geostats mining industry consultants' reference material were compared against X-Ray fluorescence machine reading to determine the calibration curves for carrying out elemental analysis. The calibration curve was constructed based on the K X-ray or L X-ray intensities evaluated for the respective elements present in standard samples. The validation of the curves constructed for elements present in the standards was checked through analysis of standard reference materials. The results obtained for the comparisons are shown in Table 1. All results in respect of the compared values were found to vary within acceptable range of error, and a plot of machine reading to certified values shows a good liner relationship.

Table 1.Calibration concentration standards

XRF	Standard	Note	Type
7.87	11.26	Pb	Standard
8	11.26	Pb	Standard
7.76	11.26	Pb	Standard
3.05	4.27	Pb	45276
3.1	4.27	Pb	45276
2.96	4.27	Pb	45276
2.27	3.1169	Pb	45272
2.29	3.1169	Pb	45272
2.28	3.1169	Pb	45272

3. HEALTH RISK ASSESSMENT MODEL

3.1 Theory of Risk Assessment. Health risk assessment format used in this work is based on the method developed by the United States Environmental Protection Agency, the layout consist of; hazard identification, exposure assessment, dose-response assessment and risk characterization (USEPA, 2001).

3.2 Hazard identification is quantitatively determined by isolation of chemicals of potential concerns (COPCs) as obtained from result of sample analyzed using data developed by acceptable regulatory benchmarks as enlisted by Shacklette, H.T., and Boerngen, J.G., 1984. Updated version 2008.

3.3 Exposure assessment estimates the intensity, frequency, and duration of human exposures to an environmental contaminant. In the present study, exposure assessments were accessed by application of equations 1-3. To determine intake values via ingestion, inhalation and dermal exposures to the workers in the mine wells.

$$AD_{ing} = \frac{C\ X\ IR_{ing}\ X\ EF\ X\ ED\ X\ CF}{BW\ X\ AT} \text{ .... } 1$$

$$AD_{inh} = \frac{C\ X\ IR_{inh}\ X\ EF\ X\ ED}{PEF\ X\ BW\ X\ AT} \text{ .... } 2$$

$$AD_{der} = \frac{C\ X\ CF\ X\ SA\ X\ SL\ X\ ABS\ X\ EF\ X\ ED}{BW\ X\ AT} \text{ .... } 3$$

Where AD ($mg{\cdot}kg^{-1}{\cdot}day^{-1}$) is the absorbed dose of exposure to heavy metals or metalloids through ingestion (ADing), inhalation (ADinh) and dermal contact (ADder); C ($mg{\cdot}kg^{-1}$) is the concentration of the metals. Parameters used in average daily dose estimation are shown in Table 2.

Table 2. Exposure parameters used for the health risk assessment

Parameter	unit	Definition	Value	reference
Cs	Mg/Kg	Heavy metal concentration of sample		
ABS	-	Dermal Absorption Factor	0.01	RSL, 2011
SL	Mg/cm^3	Soil to skin Adherence Factor	0.07	RAIS, 2011
BW	Kg	Average body weight	61.8	USEPA (2004)
ED	year	Exposure duration	30	RAIS, 2011
EF	day/year	Exposure frequency	350	RAIS, 2011
ET	hr/day	Exposure time	24	RAIS, 2011
IRing	Mg/day	Soil Ingestion rate for receptor	100	RAIS, 2011
IRinh	m3/day	Inhalation rate	20	Van den Berg, 1995
SA	Cm^3/day	Skin surface available for exposure	5,700	RAIS, 2011
Atnc	d	Averaging time for non-carcinogenic	ED X 365	RAIS, 2011
ATc	d	Averaging time for carcinogenic	LT X 365	RAIS, 2011
LT	year	Life time	70	WHO, 2006
CF	kg/mg	Conversion Factor	6-Oct	USEPA (1989)
PEF	m^3/kg	Particulate emission factor	$1.3\ X\ 10^9$	DEA, 2010

3.4 Dose-Response assessment estimates the toxicity due to exposure levels of chemicals. The cancer slope factor (CSF) and the reference dose (RfD, a non-carcinogenic threshold) are two important toxicity indices used. RfD values are derived from animal studies using the "No observable effect level", (NOEL), principle. For humans, RfD values are multiplied 10-fold to account for uncertainties (USEPA1989, Caspah et.al., 2016). Table3 shows the RRDs and SF values of the three COPCs identified in the study.

Table3. Reference dose(Rrd) and Cancer Slope Factors of Isolated COPCs

REFERENCE DOSE (RFD)						
COPC	Oral RFD	Reference	Inhalation RFD	Reference	Dermal RFD	Reference
Fe	7.00E-01	PPRTV(USEPA, 2011c)	NA	NA	1.40E-01	Naveedullah , 2014
Mn	2.40E-02	DEA, 2010	5.00E-05	DEA, 2012	5.60E–03	EPA IRIS
As	3.00E -04	DEA, 2010	1.50E -05	Cal. EPA, 2008	3.00E-04	DEA, 2010
CANCER SLOPE FACTOR(CSF)						
COPC	Oral CSF	Inhalation CSF	Dermal CSF	Reference		
As	1.50E+00	1.50E+01	1.50E+00	DEA,2010 and USEPA, 1991		

3.5 Health Risk characterization

3.5.1 Non-Carcinogenic Risk Assessment

Non-carcinogenic hazards, denoted by hazard quotient (HQ), is dose per toxicity threshold value (reference dose, RFD, in mg/kg-day of a specific heavy metal as shown in Equation (4) (USEPA,1989):

$$HQ = \frac{AD_{in}}{RFD} \quad \text{..........} 4$$

The non- carcinogenic effect to a given population due to a number of isolated heavy metal/COPCs is the outcome of summation of all the HQs due to each of the heavy metals/COPCs and is described by the term Hazard index, (HI);

$$HI = HQ = \frac{AD^{in}}{RFD} \quad \text{..........} 5$$

Where HQ, ADin and RFD are values of due to the individual COPC. Where the resulting hazard index, HI, value is less than one, the population exposed is unlikely to experience adverse health effects, If, however, the HI value exceeds one, then there may be concern for potential non-carcinogenic effects (USEPA, 1989).

3.5.2 Carcinogenic Risk Assessment

For carcinogens, the risk estimates are based on incremental probability of an individual developing cancer over a lifetime as resulting from exposure to the potential carcinogen. This is expressed by the equation,

$$Risk_{pathway} = Ad_{in} \times CSF \text{..........} 6$$

Where, Risk is a probability of an individual developing cancer over a lifetime. ADin (mg/kg/day) and CSF (mg/kg/day)-1 are the mean intake and the cancer slope factor, respectively, for the particular COPC concerned. The total excess lifetime cancer risk for an individual is calculated from the mean contribution of the individual heavy metals/COPCs for all the pathways;

$$Risk\ (total) = Risk\ (ing) + Risk\ (inh) + Risk\ (der) \text{..........} 7$$

Where Risk (ing), Risk (inh), and Risk (der) are risks contributions through ingestion, inhalation and dermal pathways.

4. RESULTS AND DISCUSSION

Table3 is a compacted presentation reflecting the values of output of assessment of each of the elements per sampled mine well and the regulatory limits for human health exposure safety as identified by United States Environmental Protection Agency (U.S.E.P.A). The benchmark data were obtained from shacklette, H.T. and Boerngen J.G 1984 (Updated March 21, 2008).

Table 4. Concentrations of Heavy Metals(HMs)in Soil of Kamfani Kwali gold mine

HMs	C1S1	C2S1	C3S1	C4S1	C6S1	C7S1	C8S1	Mean	Max.	Min.	Reg. Limit USEPA
Mo	4.002	3.758	4.02	4.27	3.181	2.857	2.964	3.578857	4.27	2.857	390
Zr	293.29	289.184	263.784	300.085	237.658	233.414	202.957	260.0531	300.085	202.957	N.S.L.
Sr	316.589	188..525	189.685	178.984	228.647	317.832	179.616	235.2255	317.832	178.984	47000
Rb	129.744	111.957	141.159	79.411	57.007	91.898	40.356	93.076	141.159	40.356	N.S.L.
Th	62.75	51.792	8.167	6.929	5.021	12.357	5.609	21.80357	62.75	5.021	N.S.L
Pb	33.277	61.515	22.896	11.288	14.731	27.234	9.749	25.81286	61.515	9.749	400
As	160.267	173.542	95.604	47.857	47.411	120.356	616.632	180.2384	616.632	47.411	27
Zn	24.131	36.348	31.035	33.586	55.309	44.654	28.144	36.17243	55.309	24.131	23000
Cu	242.717	220.289	820.094	150.836	71.801	264.055	58.105	261.1281	820.094	58.105	2900
Ni	69.96	79.77	188.77	112.706	98.258	88.97	26.21	94.94914	188.77	26.21	1600
Co	<LOD	194.281	155.796	73.556	178.948	145.133	101.482	141.5327	194.281	73.556	900
Fe	82653.6	75056.41	90138.96	75824.88	73703.52	61835.38	27844.3	69579.58	90138.96	27844.3	55000
Mn	3116.02	2204.756	3648.809	2955.953	1322.435	2156.502	914.629	2331.3	3648.809	914.629	3200
Cr	74.036	128.451	258.028	231.999	231.272	279.975	57.118	180.1256	279.975	57.118	390
V	210.847	208.935	215.836	178.739	191.121	153.45	110.742	181.3814	215.836	110.742	N.S.L
Sc	61.545	50.389	41.997	43.675	83.357	44.98	22.157	49.72857	83.357	22.157	N.S.L
Ca	12935.7	12501	11781.07	13563.57	15235.86	13111.87	4962.84	12013.12	15235.86	4962.84	N.S.L
K	30621	23599.53	25623.1	15127.36	19373	23568.29	14787.1	21814.2	30621.01	14787.1	N.S.L
Ba	1250.26	801.354	1104.982	895.126	857.098	987.946	435.673	904.6346	1250.263	435.673	16000
Sb	<LOD	<LOD	15.316	10.702	<LOD	<LOD	<LOD	13.009	15.316	10.702	31
Sn	14.361	11.163	16.052	11.299	<LOD	<LOD	<LOD	13.21875	16.052	11.163	N.S.L

<LOD =Below Limit of Detection, N. S. L. =No Screening Level

4.1 Selection of Chemicals of Potential Concern

By comparing obtained results to regulatory limits, it can be observed that three elements have range of values that overshoot the limits; Manganese (Mn), Iron (Fe) and Arsenic (As). These heavy metals and metalloids were thus isolated as Chemicals of Potential Concern (COPC) upon which risk- based assessments were done to clarify their status.

Manganese; is an essential trace elements in the metabolism of all living organisms, animals or plants. Normally it is found in human blood with concentration <320 nmolL-1 and functions as a cofactor for some enzymes. Exposure of man to high levels of manganese leads to hypermangesaemia (high Mn levels in blood) and defect in its metabolism with its accumulation in the liver and basal ganglia is lethal (Tuschl et al.,2008). Manganese exposure is usually via inhalation (the risk varying with manganese species involved and with particle size) (Abel -Ghany, 2010). Manganese poisoning may result from prolonged inhalation of dust and fume. Soil particulate matter containing manganese can be transported in air. The fate and transport of manganese in air are largely determined by the size and density of the particle and wind speed and direction (WHO, 1999). In addition to the risk of exposure to high dose, manganese provides another risk factor if the ore contains residual radioactive elements. Viewing the consistently raised concentrations of Manganese across all the assessed samples with ranges between 914.629 ppm and 3648.809 ppm.

The mean concentration of Iron (Fe) content was highest in the samples with value of 69579.58 ppm. The benchmark by EPA indicates a top limit of 55000 ppm. The raised level of Iron concentration in all the stages is a call for concern because high intake of iron through any of the pathways when individual is exposed may results into hepatic megaly, cardiac infection and nephric malfunction.

Arsenic levels across all sampled mine wells are many folds above regulatory limit with the least value being 47.41 ppm while maximum occurs at C8S1 with alarming record of 616.632 ppm; a value of many times above the set limit. Contamination with the high levels of arsenic is of concern because arsenic can cause a number of human health effects. Several epidemiological studies have reported a strong association between arsenic exposure and increased risks of both carcinogenic and systemic health effects (Tchounou, 2003). The severity of adverse health effects is related to the chemical form of arsenic, and is also time and dose dependent (Tchounwou et.al.,2002, Yedjou GC, 2006). Analyzing the toxic effects of arsenic is complicated because the toxicity is highly influenced by its oxidation state and solubility, as well as many other intrinsic and extrinsic factors (Centeno, 2005). Several studies have indicated that toxicity of arsenic depend on the exposure dose, frequency, and duration, the biological species, age, and gender as well as on individual susceptibilities, genetic and nutritional factors (Abernathy, 1999). Most cases of human toxicity from arsenic have been associated with exposure to inorganic arsenic. Inorganic trivalent arsenite (As III) is 2-10 times more toxic than pentavalent arsenate (As V)(Goyer,2001). By binding to thiol or sulfhydrl groups on proteins, As (III) can inactivate over 200 enzymes. This is the likely mechanism responsible for arsenic's widespread effects on different organ system. As (V) can replace phosphate, which is involved in many biochemical pathways (Goyer, 2001, Hughes, 2002).

4.2 Risk Assessment

(A) Non-carcinogenic

Non carcinogenic risk of occupational workers in the mining facility were assessed based on RFD values as presented in Table 3 and ADI values in Table 5..The outcomes of the assessment for the ingestion, inhalation and dermal pathways are all presented in terms of HQs as shown in Table6.When the hazard indices, HQ and HI are less than unity, outcomes are considered of no risk to the occupational population, however, where these values exceed one concern for potential non-carcinogenic effects arises.(US EPA, 2004).

Table5. Average daily intake (ADI) values COPCs in mg/kg/day of workers for non-carcinogenic risk calculations

Intake parameter	As	Mn	Fe
ADing	2.80E-04	3.62E-03	1.08E-01
ADinh	4.30E-08	5.57E-07	1.66E-05
ADderm	6.81E-05	8.80E-05	2.63E-03

From table 6, the total risk from the three pathways of ingestion, inhalation and dermal contact reveals that only Arsenic added up to unity in its pathway analysis of hazard quotients, HI, with a summed value of 1.13E+00.This raised value indicated Arsenic pollution that may be directed at a very high non cancer occupational health risk to the artisanal mine workers at the mine site. The outcome also indicate that, the contributions to risk from the three pathways are in the order of ingestion>dermal>inhalation.

Table6. Hazard quotient and hazard index of COPCs

Hazard Indices	As	Mn	Fe
HQing	9.00E-01	1.50E-01	1.50E-01
HQinh	2.87E-03	1.11E-02	NIL
HQderm	2.27E-01	1.57E-02	1.88E-02
HI(non-carcinogenic)	**1.13E+00**	**1.77E-01**	**1.69E-01**

(B) Carcinogenic Risk Assessment

The excess lifetime cancer risks for the occupational workers are calculated from the average contribution of only Arsenic out of the three COPCs isolated for all the pathways using Equations (6) on the risk pathway and (7) on risk total.. Based on the carcinogenic risk values of the calculated ADI values presented in Table 7, the results of the excess lifetime cancer risks are presented also in the compacted table.

Table 7. Mean Daily intake and Hazard indices for carcinogenic assessments

Mean daily accidental intake of Arsenic		Hazard Indices	
ADing	1.20E-04	RIing	1.80E-04
ADinh	1.84E-08	RIinh	2.76E-07
ADderm	2.92E-06	RIderm	4.38E-06
		RI	**1.85E-04**

The US Environmental Protection Agency considers acceptable for regulatory purposes a cancer risk in the range of 1 X 10-6 to 1 X 10-4 (USEPA, 2004). The cancer risk for due to accidental ingestion of soil and dermal contact with soil in this study were 1.80 x 10-4 and 1.85x 10-4 respectively, falling into acceptable ranges for in-cave miners by USEPA benchmark, however, the corresponding value for inhalation of Arsenic in dust of the mining cave was 2.76 x 10-7 . This value falls outside the USEPA safe range. In this particular study, mine workers are more at risk from inhalation route than ingestion and dermal contact. Thus inhalation route, by findings, is the major contributor to excess lifetime risk of cancer, even though, the overall hazard index yields 1.85 x 10-4 being within the benchmark limit set by EPA.

5. CONCLUSION

The outcome of this study revealed that artisanal mine workers in the site under considerations are at risk of developing carcinogenic and non-carcinogenic diseases mainly due to exposure to inorganic Arsenic.. The observed cumulative Hazard Index from the three pathways, HI, of 1.13E+00.is an indication of Arsenic pollution that may be directed at a very high non cancer occupational health risk. It can be deduced that all the pathways of inhalation, ingestion and dermal contact are active contributors to the possibilities of non-carcinogenic risks. The risk pattern carved out at the carcinogenic level reveals inhalation of Arsenic in dust of the mining cave was 2.76 x 10-7. This is an elevated value outside the USEPA safe range indicating that inhalation is the major carcinogenic health risk probability. It is of necessity that further studies on bioavailability of Arsenic is undertaken to determine further, the degree to which these workers may be affected by exposure to Arsenic. The outcome of such studies could assist the State and Federal Environmental Protection Agencies (FEPA) of Nigeria on policy formulations that will protect these local miners in the region. Viewing Manganese concentration, It would have been suffice to state that Manganese poses health threat in the mine wells to the artisanal miners who by and large do not use face mask in carrying out their exercises in these wells under consideration, however, by integrating the exposure parameters into the elevated values of concentrations recorded, then it can be said to constitute no health risk by the level. Similar argument ends the risk estimates of Fe too.

6. REFERENCES

- *Abdullahi I. Tsafe and Alhassan Yahaya (2016). Levels of Lead in Potable Water Sources of Artisanal Gold Mining Town of Bagega, in Northern Nigeria. Vth International Symposium on "Fusion of Science & Technology", New Delhi, India, January 18-22, 2016*
- *Abel-Ghany, H.A (2010). Natural Activities of 238U, 232Th and 40K in Manganese ore, American Journal of Environmental Sciences 6 (1): 90-94,2010 ISSN 1533-345X (c) 2010 Science Publications*
- *Abernathy CO, Liu YP, Longfellow D, Aposhian HV, Beck B, Fowler B, Goyer R, Menzer R, Rossman T, Thompson C, Waalkes R (1999) Arsenic: health effects, mechanisms of actions and research issues. Environ Health Perspect 107: 593-597*
- *Agency for Toxic Substances and Disease Registry (ATSDR) (2000) Toxicological Profile for Arsenic TP-*

92/09. Centre for Disease Control, Atlanta Georgia

- Ako T.A , Onoduku U.S, Oke S.A., Adamu I.A., Ali S.E., Mamodu A., Ibrahim A.T. (2014). Environmental Impact of Artisanal Gold mining in Luku, Minna, Niger State, North Central Nigeria. Journal of Geosciences and Geomatics 2014, Vol 2, No. 1, 28-37 Available online at http://pubs.sciepub.com/jgg/2/1/5 (c) Science and Education Publishing DOI:10.12691/jgg-2- 1-5.
- Azubike, A.L. (2011) The technology of peaty soils in Mozambique and Angola. Transactions of the 5th International Congress of Soil Science, Leopoldville 3:398-401
- Bradshaw, A.D (1997). Restoration of minded lands-using natural process. Ecological Engineering, 8:255-269. Centers of Disease Control and Prevention (CDC,2012). Health Informatics for travelers to Nigeria. http://www.nc.cdc.gov/travel/destination/nigeria.aspx Accessed on 22/12/2012
- CalEPA, 2008. California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, Air Toxics Hot Spots Program Technical Support Document for the Derivation of Noncancer Reference Exposure Levels, December 2008
- Caspah Kamunda, Manny Mathuthu and Morgan Madhuku (2016). Health Risk Assessment of Heavy Metals in Soils from Witwatersrand Gold Mining Basin, South Africa. International Journal of Environmental Research and Public Health, 2016, 13, 663; doi:10.3390/ijerph13070663 www.mdpi.com/journal/ijerph
- Centeno JA, Tchounwou PB, Patlolla AK, Mullick FG, Murakat L, Meza E, Gibb H, Longfellow D, Yedjou CG (2005). Environmental pathology and health effects of arsenic poisoning: a critical review. In: Naidu R, Smith J, Bhattacharya P (eds.): Managing Arsenic in the environment: From Soil to Human Health. CSIRO Publishing Corp. Adelaide, Australia
- Centers for Disease Control and Prevention (CDC, 2001). Managing Elevated Blood Lead Levels Among Young Children: Recommendations From the Advisory Committee on Childhood Lead Poisoning Prevention. Atlanta: 2001
- DEA, 2010. Department of Environmental Affairs. The Framework for the Management of Contaminated Land, SouthAfrica. 2010. Available online: http://sawic.environment.gov.za/documents/562.pdf
- Goyer RA (2001) Toxic effects of metals. In: CD Klassen (eds.): Cassarett and Doull's Toxicology: The Basic Science of Poisons. Mc Graw-Hill Publisher. New York. 811-867
- Hughes MF (2002). Arsenic toxicity and potential mechanisms of action. ToxicoILett 133: 1 -16 Kafrista, Y., J. Fell, S. Long, M.Bynevelt, W. Taylor and P. Milla, (1998). Long-term outcome of brain manganese deposition in patients on home parental nutrition. Arch. Dis. Child., 79:263-265. DOI: 10.1136/adc.79.3.263
- Kogo, B.E. Gajere, E.N Ogunmola J.K and Ogbole J.O (2009), Neutron Activation Analysis of Soil samples from different parts of Abuja Metropolis Middle-East J. Scientific Research 4 (4) 254- 262.
- MedecinsSansFrontieres (MSF,2010). Nigeria Country Security and Safety Plan-Draft 1, May,2010
- Naveedullah NZ, Chunna Y, Hui S, Dechao D, Chaofeng S, Liping L and Yinexu C.(2014). Concentration and human health risk assessment of selected heavy metals in surface water of the Siling reservoir watershed in Zhejing Province, China. Polish Journal Environment Studies. 2014; 23(3): 801-811.
- Ogwuegbu, M. O. C. and Muhanga, W. (2005). "Investigation of Lead Concentration in the Blood of People in the Copperbelt Province of Zambia," Journal of Environment, 1 66-75.
- PPRTV (USEPA), 2011c. Provisional Peer Reviewed Toxicity Values for Superfund, Office of Superfund Remediation and Technology Innovation, Washington, D.C., http://hhpprtv.ornl.gov/index.shtml
- RAIS, (2011). U.S. Department of Energy. The Risk Assessment Information System; U.S. Department of Energy's Oak Ridge Operations Office (ORO): Oak Ridge, TN, USA, 2011.
- RSL, (2011). Regional Screening Level Table for Chemical Contaminants at Superfund Sites; U.S. Environmental Protection Agency: Washington, DC, USA, 2011
- Samuel Obiri, Philip O. Yeboah, Shiloh Osae, Sam Adu-kumi, Samuel J. Cobbina, Frederick A. Armah, Benjamin Ason, Edward Antwi and Reginald Quansah (2016). Human Health Risk Assessment of Artisanal Miners Exposed to Toxic Chemicals in Water and Sediments in the Prestea Huni Valley District of Ghana. International Journal of Environmental Research and Public Health. Vol. 13, 139; doi:10.3390/ijerph13010139. www.mdpi.com/journal/ijerph
- Shacklette, H.T., and Boerngen, J.G., 1984. Element concentrations in soils and other surficial materials of the conterminous United States: U.S Geological Paper 1270, 105 p. http://pubs.usgs.gov/pp/1270/
- Tchounwou PB, Wilson BA, Abdelgnani AA, Ishaque AB, Patlolla AK (2002) Differential cytotoxicity and gene expression in human liver carcinoma (HepG2) cells exposed to arsenic trioxide and monosodium acid methanearsonate (MSMA). Intl J MolSci 3: 1117-1132
- Tchounwou PB, Patlolla AK, Centeno JA (2003) Carcinogenic and Systemic health effects associated with arsenic exposure-a critical review. ToxicolPathol 31(6): 575-588
- Tuschl, K., P.B. Mills, H. Parsons, M. Malone and D. Fowler et al., (2008). Hepatic cirrhosis, dystonia,

polycythaemia and hypermanganesaemia- A new metabolic disorder. J. Inherit. Metab. Dis., 31: 151-163. PMID:18392750
- *USEPA, 2001. United States Environmental Protection Agency. Toxics Release Inventory: Public Data Release Report. 2001. Available online: www.epa.gov/tri/tridata/tri01.*
- *USEPA (2004). United States Environmental Protection Agency. Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part E, Supplemental Guidance for Dermal Risk Assessment), USEPA: Washington, DC, USA, 2004; Volume 1.*
- *US-EPA (1994a). The Integrated Risk Information Service (IRIS) Online, Office of Environmental Health and Environmental Assessment, Environmental Criteria and Assessment Office, Cincinnati, OH. US Environmental Protection Agency, Washington, DC, USA.*
- *USEPA (1993). Reference Dose (RfD): Description and Use in Health Risk Assessments Background Document 1A March 15, 1993.Last updated on September 28, 2016*
- *USEPA (1989). United States Environmental Protection Agency, Risk Assessment Guidance for Superfund: Human Health Evaluation Manual (Part A); EPA/540/1–89/002; USEPA: Washington, DC, USA, 1989; Volume 1.*
- *Van den Berg, R. (1995). Human exposure to soil contamination: a qualitative and quantitative analysis towards proposals for human toxicological intervention values. RIVM Report no. 725201011. Bilthoven, The Netherlands: National Institute of Public Health and Environmental Protection (RIVM).*
- *Veiga, M.M. (2003) Mercury in artisanal gold mining in Latin America:facts, fantasies and solutions, UNIDO Expert Group meeting- Introduction new technologies for abatement of global mercury pollution deriving from artisanal gold mining, Vienna, Austria, 2003*
- *World Health Organization (WHO) Geneva,1999. Manganese and its compounds. Published under the joint sponsorship of the United Nations Environment Programme, the International Labour Organization, and the World Health Organization, and produced within the framework of the Inter-Organization Programme for the Sound Management of Chemicals.*
- *Yedjou GC, Moore P, Tchounwou PB (2006) Dose and time dependent response of human leukemia (HL-60) cells to arsenic trioxide. Intl J Environ Res Public Health, 3(2): 136-14*

Strength Characteristics of Self-Curing Concrete Using Polyethylene Glycol (PEG)

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ABSTRACT

Today concrete is most widely used construction material due to its good compressive strength and durability. Depending upon the nature of work the cement, fine aggregate, coarse aggregate and water are mixed in specific proportions to produce plain concrete. Plain concrete needs congenial atmosphere by providing moisture for a minimum period of 28 days for good hydration and to attain desired strength. Any laxity in curing will badly affect the strength and durability of concrete. Self-curing concrete is one of the special concretes in mitigating insufficient curing due to human negligence paucity of water in arid areas, inaccessibility of structures in difficult terrains and in areas where the presence of fluorides in water will badly affect the characteristics of concrete. The present study involves the use of shrinkage reducing admixture polyethylene glycol (PEG 400) in concrete which helps in self curing and helps in better hydration and hence strength. In the present study, the affect of admixture (PEG 400) on compressive strength, split tensile strength and modulus of rupture by varying the percentage of PEG by weight of cement from 0% to 2% were studied both for M20 and M40 mixes. It was found that PEG 400 could help in self curing by giving strength on par with conventional curing. It was also found that 1% of PEG 400 by weight of cement was optimum for M20, while 0.5 % was optimum for M40 grade concretes for achieving maximum strength without compromising workability.

Keywords: : Self-curing concrete; Water retention; Relative humidity; Hydration; Absorption; Permeable pores; Sorptivity; Water permeability

1. INTRODUCTION

Adequate curing is essential for concrete to obtain structural and durability properties and therefore is one of the most important requirements for optimum concrete performance. Curing of concrete is the process of maintaining the proper moisture conditions to promote optimum cement hydration immediately after placement. With insufficient water, the hydration will not proceed and the resulting concrete may not possess the desirable strength and impermeability. The near surface region of concrete is particularly affected, failing to provide a protective barrier against ingress of harmful agents. Proper curing of concrete structures is important to meet performance and durability requirements. Enough water needs to be present in a concrete mix for the hydration of cement to take place. However, even mix contains enough water, any loss of moisture from the concrete will reduce the initial water cement ratio and result in incomplete hydration of cement especially with the mixes having low water cement ratio. This results in very poor quality of concrete.

Proper curing of concrete structures is impotant to meet performance and durability requirements. inconventional curing this is achieved by external curing applied after mixing, placing and finishing .

self- curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation

1.1 Methods of Conventional Curing

Methods of curing concrete fall broadly into the following categories:

- Ponding or spraying
- By using covering of wet hessian.
- Reducing the rate of evaporation of water from concrete surface by covering with a relatively impermeable membrane.
- Delaying the removal of form work can also be used to retain some water.
- Steam curing.

1.2 Difficulties in conventional curing methods

- For the vertical member it is not possible to keep the surface moist as in case of the flat surfaces.
- In the places where there is scarcity of water.
- In the places where manual curing is not possible.
- A human error may lead to the formation of crack in the member and hence affects strength and durability.

2. SELF-CURING

The ACI-308 Code states that "internal curing refers to the process by which the hydration of cement occurs because of the availability of additional internal water that is not part of the mixing Water." Conventionally, curing concrete means creating conditions such that water is not lost from the surface i.e., curing is taken to happen „from the outside to inside". In contrast, „internal curing" is allowing for curing „from the inside to outside" through the internal reservoirs (in the form of saturated lightweight fine aggregates, super absorbent polymers, or saturated wood fibers) Created. „Internal curing" is often also referred as „Self–curing.

Self-curing or internal curing is a technique that can be used to provide additional moisture in concrete for more effective hydration of cement and reduced self-desiccation. The concept of self-curing agents is to reduce the water evaporation from concrete, and hence increase the water retention capacity of the concrete compared to conventional concrete. It was found that water soluble polymers can be used as self-curing agents in concrete. Curing of concrete plays a major role in developing the concrete microstructure and pore structure and hence improves its durability and performance.

2.1 Methods of self curing

There are two major methods available for internal curing of concrete. The first method uses saturated porous lightweight aggregate (LWA) in order to supply an internal source of water, which can replace the water consumed by chemical shrinkage during cement hydration.

The second method uses poly-ethylene glycol (PEG) which reduces the evaporation of water from the surface of concrete and also helps in water retention.

2.2 Mechanism of Internal Curing

According to R.T.Y Liang and R.K Sun, continuous evaporation of moisture takes place from an exposed surface due to the difference in chemical potentials (free energy) between the vapour and liquid phases. The polymers added in the mix mainly form hydrogen bonds with water molecules and reduce the chemical potential of the molecules which in turn reduces the vapour pressure, thus reducing the rate of evaporation from the surface.

2.3 Need for Self–curing

When the mineral admixtures react completely in a blended cement system, their demand for curing water (external or internal) can be much greater than that in a conventional ordinary Portland cement concrete. When this water is not readily available, significant autogenous deformation and early-age cracking may result.

Due to the chemical shrinkage occurring during cement hydration, empty pores are created within the cement paste, leading to a reduction in its internal relative humidity and also to shrinkage which may cause early-age cracking. This situation is intensified in HPC (compared to conventional concrete) due to its generally higher cement content, reduced water-cement (w/ c) ratio and the pozzolanic mineral admixtures (fly ash, silica fume).

2.4 Potential Materials for Internal Curing (IC)

The following materials can provide internal water reservoirs:

- Light weight Aggregate (natural and synthetic, expanded shale)
- Super-absorbent Polymers (SAP) (60-300 nm size)
- SRA (Shrinkage Reducing Admixture)
- Wood powder.

2.5 Benefit of self-curing

- Internal curing (IC) is a method to provide the water to hydrate all the cement, accomplishing what the mixing water alone cannot do.

- Provides water to keep the relative humidity (RH) high, keeping self-desiccation from occurring.
- Eliminates largely autogenous shrinkage.
- Maintains the strengths of mortar/concrete at the early age (12 to 72 hrs.) above the level where internally & externally induced strains can cause cracking.
- Can make up for some of the deficiencies of external curing, both human related and hydration related.

2.6 Chemicals to Achieve Self–curing

Some specific water-soluble chemicals added during the mixing can reduce water evaporation from and within the set concrete, making it „self-curing." The chemicals should have abilities to reduce evaporation from solution and to improve water retention in ordinary Portland cement matrix. Followings are some of the chemicals which are hydrophilic in nature.

I. Polyvalent alcohol
ii. Polyethylene glycol (PEG)
iii. Poly-acrylic acid
iv. Xylitol, sorbitol
v. Glycerine
vi. Phytosterols
vii. Hyaluronic acid
viii Polyxyelhylene (POE)
ix Stearyl alcohol
x Cetyl alcohol
xi Urethanes
xii Sodium pyrrolidone carboxylate (PCA- Na)

3. SCOPE AND OBJECTIVE

1. The scope of the paper is to study the effect of polyethylene glycol 400 on strength characteristics of Self-curing concrete.
2. The objective is to study the mechanical characterstics of concrete such as compressive strength,, split tensile strength and modulus of rupture by varying the percentage of PEG from 0.1% to 2% by weight of cement for both M20 and M40 grades of concrete.

4. MATERIALS USED

The different materials used in this investigation are

i. Cement

The cement used in the investigation was 53-grade Ordinary Portland Cement and Portland Pozzolana Cement conforming to IS:12269-1987and IS:1489-1991 respectively.

ii. Fine Aggregate

The fine aggregate used was obtained from a nearby river course. The fine aggregate conforming to zone-II according to IS 383-1970 was used. The sand was sieved through a set of sieves (i.e. 2.36mm,1.18mm, 600µ, 300µ and150µ). Sand retained on each sieve was filled in different bags and stacked separately. To obtain zone- II sand correctly, sand retained on each sieve is mixed in appropriate proportion. The physical properties of fine aggregate and proportion in which each size fraction is mixed is shown in table 1 & 2 respectively.

Table 1 Physical Properties of fine aggregate

Fineness modulus	2.8
Bulk density	1.39gm/cc
Specific gravity	2.6

Table 2 Proportions of different size fractions of sand obtain

Sieve size (mm)	% Passing Recommended by IS:383	Adopted Grading	Cumulative (%) weight Retained	%Weight Retained	Weight Retained in (gm)
10	100	100	-	-	-
4.75	90-100	100	-	-	-
2.36	75-100	85	15	15	150
1.18	55-90	70	30	15	150
600µ	35-59	45	55	25	250
300µ	30-Aug	10	90	35	350
150µ	0-10	0	100	10	100

zone-II sand

iii. Coarse Aggregates:

The coarse aggregate used is from a local crushing unit having 20mm nominal size. 20mm well-graded aggregate according to IS-383 is used in this investigation. The coarse aggregate procured from quarry was sieved through all the sieves (i.e. 20mm, 16mm, 12.5mm. 10mm and 4.75mm). The material retained on each sieve was filled in bags and stacked separately. To obtain 20mm well-graded aggregate, coarse aggregate retained on each sieve is mixed in appropriate proportions. The physical properties and proportions in each fraction are shown in table 3&4 respectively.

Table 3 Physical properties of coarse aggregate

Fineness modulus	7.35
Bulk density	1.59gm/cc
Specific gravity	2.67

Table 4 Proportions of different size fraction of coarse aggregate to obtain 20mm well-graded aggregate

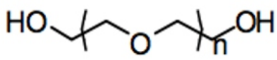
Sieve size (mm)	% Passing Recommended by IS- 383	Adopted Grading	Cumulative (%) Weight Retained	% Weight Retained	Weight Retained In(gm)
40	100	100	-	-	-
20	95-100	100	-	-	-
16	67-82	70	30	30	3000
12	42-66	45	55	25	2500
10	25-55	30	70	15	1500
4.75	0-10	0	100	30	3000

iv. Polyethylene glycol (PEG)

Polyethylene glycol is a condensation polymers of ethylene oxide and water with the general formula H(OCH2CH2)nOH, where n is the average number of repeating oxyethylene groups typically from 4 to about 180. The low molecular weight members from n=2 to n=4 are diethylene glycol, triethylene glycol and tetraethylene glycol respectively, which are produced as pure compounds. The low molecular weight compounds up to 700 are colourless, odourless viscous liquids with a freezing point from 10 °C (diethylene glycols), while polymerized compounds with higher molecular weight than 1,000 are wax like solids with melting point up to 67 °C for n 180. The abbreviation (PEG) is termed in combination with a numeric suffix which indicates the average molecular weights. One common feature of PEG appears to be water-soluble. The specifications of PEG 200 & PEG 4000 are shown in table 5.

It is also soluble in many organic solvents including aromatic hydrocarbons (not aliphatic). They are used to make emulsifying agents and detergents, and as plasticizers, humectants, and water- soluble textile lubricants.

Polyethylene glycol is non-toxic, odourless, neutral, lubricating, non-volatile and no irritating and is used in a variety of pharmaceuticals and in medications as a solvent, dispensing agent, ointment and suppository bases, vehicle, and tablet excipient. The chemical structure of PEG is shown below.



Polyethylene glycol is produced by the interaction of ethylene oxide with water, ethylene glycol or ethylene glycol oligomers.

5. EXPERIMENTAL PROGRAMME

The experimental program was designed to investigate the strength of self curing concrete by adding poly ethylene glycol PEG400 @ 0.5%, 1%, 1.5% and 2% by weight of cement to the concrete. The experimental program was aimed to study the workability, compressive strength, split tensile strength and modulus of rupture. To study the above properties mixes M20 and M40 were considered. The scheme of experimental program is given in Table No.1

SL. No	Nature	M20			M40		
		Cube *	Cylinder #	Prism$	Cube	Cylinder	Prism
1	Plain	3	3	3	3	3	3
2	0.5%	3	3	3	3	3	3
3	1%	3	3	3	3	3	3
4	1.5%	3	3	3	3	3	3
5	2%	3	3	3	3	3	3

*The size of each cube is 150 x150 x150 mm. # The size of each cylinder is 150 mm in dia and 300 mm in height. $ The size of each prism is 100 x100 x400 mm Table 1: Details of specimens cast.

5.1 Casting Programme:

Casting of the specimens were done as per IS:10086-1982, preparation of materials, weighing of materials and casting of cubes, cylinders, beams.

The mixing, compacting and curing of concrete are done according to IS 516: 1959. The plain samples of cubes, cylinders and prisms were cured for 28 days in water pond and the specimens with PEG400 were cured for 28 days at room temperature by placing them in shade. The M20 and M40 grades of concrete are designed and the material required per cubic meter of concrete is shown in Table 2.

SL. No	Mix	Cement (kg)	Fine Aggregate (kg)	Coarse Aggregate (kg)	Water (kg)
1	M20	340	610	1300	187
2	M40	440	520	1220	154

Table 2: Materials required per cubic meter of concrete

5.2 Testing

5.2.1 Slump Test & Compaction Factor.

Slump test is the most commonly used method of measuring consistency of concrete which can be employed either in laboratory or at site of work. It does not measure all factors contributing to workability. However, it is used conveniently as a control test and gives an indication of the uniformity of concrete from batch to batch. The compacting factor test is designed primarily for use in the laboratory but it can also be used in the field. It is more precise and sensitive than the slump test and particularly useful for concrete mixes of very low workability as are normally used when concrete is to be compacted by vibration. Such dry concretes are insensitive to slump test.

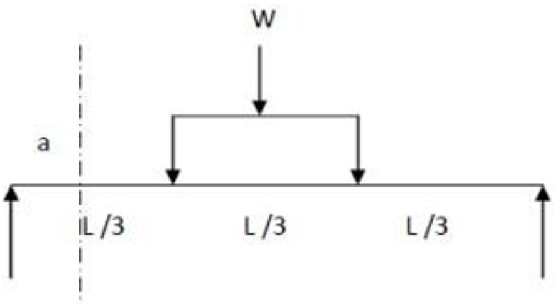
5.2.2 Compressive strength:

The cube specimens were tested on compression testing machine of capacity 3000KN.The bearing surface of machine was wiped off clean and sand or other material removed from the surface of the specimen. The specimen was placed in machine in such a manner that the load was applied to opposite sides of the cubes as casted that is, not top and bottom. The axis of the specimen was carefully aligned at the centre of loading frame. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. $f_c = P/A$, where, P is load & A is area.

5.2.3 Split Tensile Strength:

The cylinder specimens were tested on compression testing machine of capacity 3000KN.The bearing surface of machine was wiped off clean and looses other sand or other material removed from the surface of the specimen. The load applied was increased continuously at a constant rate until the resistance of the specimen to the increasing load breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. fsplit =2 P/πDL, where P=load, D= diameter of cylinder, L=length of the cylinder.

$f_{rup.} = (3Wa)/(bd^2)$, where W = load at failure,
L = length of specimen (400mm)
b = width of specimen (10mm),
d=depth of specimen (100mm)



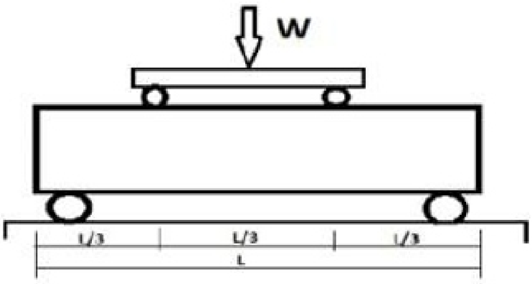


Fig 3: Specimens while testing

The beam specimens were tested on universal testing machine for two-point loading to create a pure bending. The bearing surface of machine was wiped off clean and sand or other material is removed from the surface of the specimen. The two point bending load applied was increased continuously at a constant rate until the specimen breaks down and no longer can be sustained. The maximum load applied on specimen was recorded. The test set–up is shown in Fig. 2. The modulus of rupture depends on where the specimen breaks along the span. The specimens while testing compressive strength, split tenslie & Modulus of ruptrure is shown in Fig 3.

6. RESULTS & DISCUSSION

6.1 Slump and Compaction factor test:

The results of the Slump & Compaction factor test were represented in Table 3. The graphical representation of the Slump & Compaction factor results is shown in Fig 4 and Fig 5 respectively. As the % of PEG400 is increased the slump and compaction factor is found to increase. But, the rate of increase of slump & compaction factor for M40 concrete is less than that of M20 plain concrete.

Sl. No	PEG 400	Slump (mm)		Compaction Factor	
		M20	M40	M20	M40
1	Plain	80	45	0.88	0.85
2	0.50%	92	65	0.90	0.87
3	1.00%	112	95	0.91	0.90
4	1.50%	140	130	0.93	0.91
5	2.00%	175	160	0.96	0.94

Table 3: Results of Workability

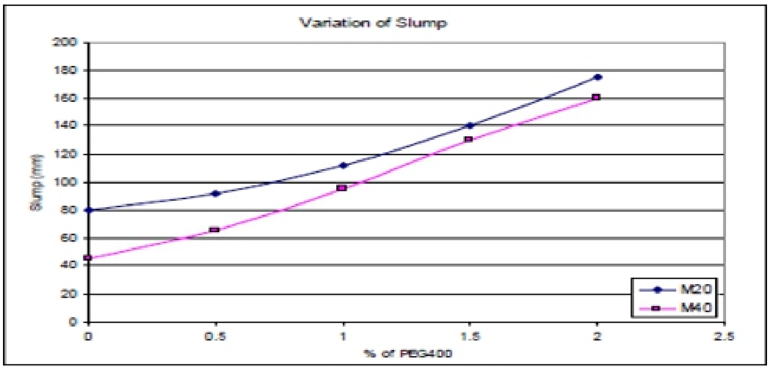


Fig 4. Variation of Slump

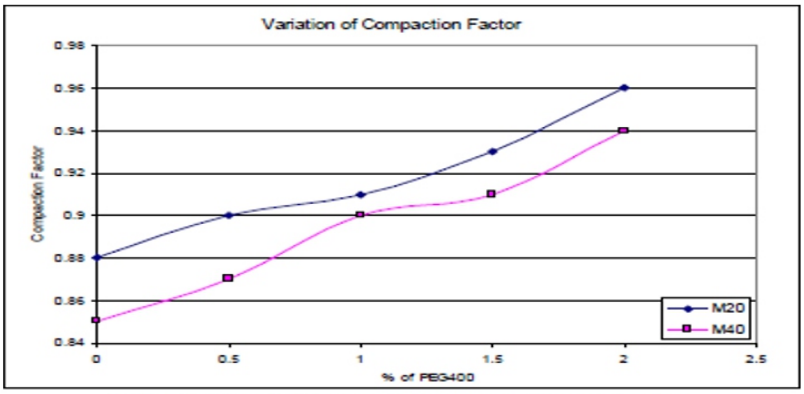


Fig 5. Variation of Compaction Factor

6.2 Compressive Strength

The results of the compressive strength are represented in Table 4 and the graphical representation is shown in Fig 6. The compressive strength was found to increase up to 1% PEG400 and then decreased for M20 grade. In the case of M40 compressive strength increased up to 0.5% and then decreased. The increase in compressive strength was 7.23% at 1% of PEG 400 compared to conventional concrete for M20, while the increase is 1.24% at 0.5% of PEG400 in case of M40 grade of concrete.

Sl. No	PEG	f_c (N/mm²)		f_{split} (N/mm²)		f_{rup} (N/mm²)	
		M20	M40	M20	M40	M20	M40
1	Plain	26.60	46.65	1.81	2.42	3.50	4.62
2	0.50%	27.61	47.23	1.96	2.50	3.75	4.75
3	1.00%	28.49	45.93	2.02	2.45	3.80	4.64
4	1.50%	26.74	44.62	1.92	2.34	3.68	4.53
5	2.00%	25.03	42.44	1.85	2.25	3.55	4.46

Table 4: Mechanical Properties

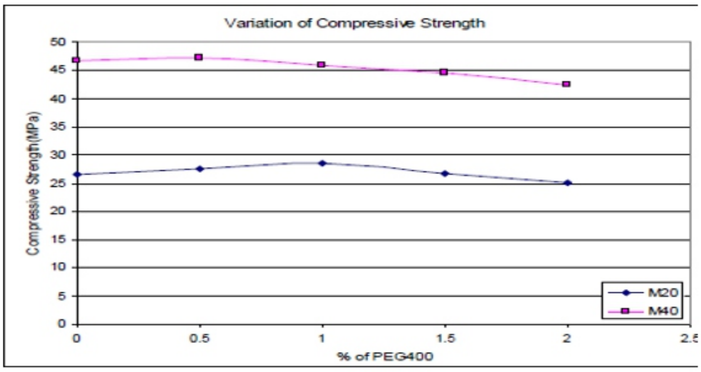


Fig 6. Variation of Compressive Strength

6.3 Split Tensile Strength:

The results of the split tensile strength are represented in Table 4 and the graphical representation is shown in Fig 7. The split tensile strength was found to increase up to 1% PEG400 and then decreased for M20 grade. In the case of M40 split tensile strength increased up to 0.5% and then decreased. The increase in split tensile strength was 11.60% at 1% of PEG400 compared to conventional concrete for M20, while the increase is 3.30% at 0.5% of PEG400 in case of M40 grade of concrete.

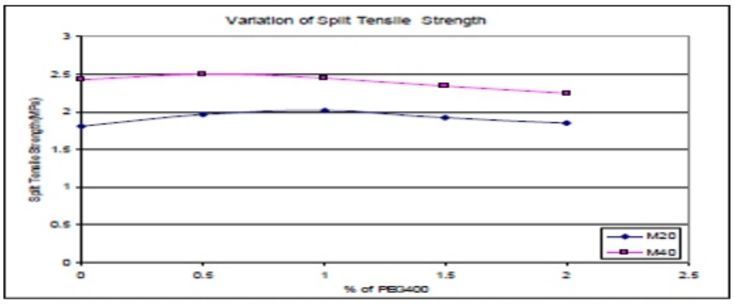


Fig 7. Variation of Split Tensile Strength

6.4 Modulus of rupture:

The results of the modulus of rupture are represented in Table 4 and the graphical representation is shown in Fig 8. The modulus of rupture was found to increase up to 1% PEG400 and then decreased for M20 grade. In the case of M40 modulus of rupture increased up to 0.5% and then decreased. The increase in modulus of rupture was 8.57% at 1% of PEG 400 compared to conventional concrete for M20, while the increase is 2.81% at 0.5% of PEG400 in case of M40 grade of concrete.

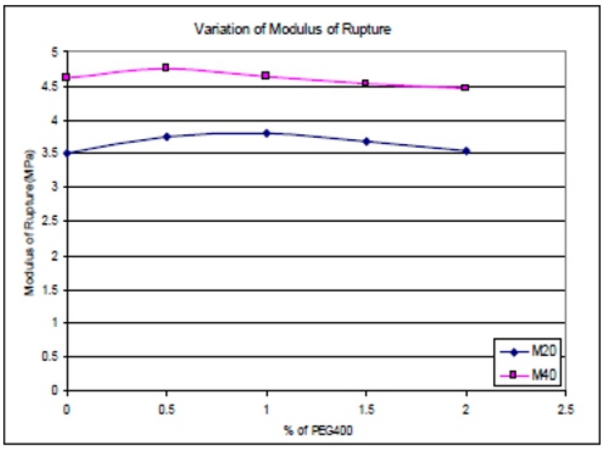


Fig 8. Variation of Modulus of Rupture

7. CONCLUSIONS:

1. The optimum dosage of PEG400 for maximum strengths (compressive, tensile and modulus of rupture) was found to be 1% for M20 and 0.5% for M40 grades of concrete.

2. As percentage of PEG400 increased slump increased for both M20 and M40 grades of concrete.

3. Strength of self curing concrete is on par with conventional concrete.

4. Self curing concrete is the answer to many problems faced due to lack of proper curing.

8. REFERENCES

1. *Wen-Chen Jau"Self-curing Concrete", United States Patent Application Publication, Pub. No: U.S. 2008/0072799 A1, Pub.date: Mar. 27,2008.*
2. *Roland Tak Yong Liang,Robert Keith Sun, " Compositions and Methods for Curing Concrete", Patent No .: US 6,468,344 B1, Date of Patent Oct. 22, 2002.*
3. *A.S.El-Dieb, "Self-curing Concrete: Water Retention, hydration and moisture transport", Construction and Building Materials Vol.21 (2007) 1282-1287.*
4. *A.S. El-Dieb, T.A. El-Maaddawy and A.A.M. Mahmoud,"Water-Soluble Polymers as Self-Curing Agent in Silica Fume Portland Cement Mixes", ACI Material Journal Vol.278 (2011) 1-18.*
5. *Raghavendra Y.B and Aswath M.U,"Experimental investigation on concrete cured with various curing Methods-A Comparative Study",International Journal of Advanced Scientific Research and Technology, Issue: 2, Vol.3 (2012) 577-584.*
6. *Jagannadha Kumar M.V, Srikanth M, Rao K.Jagannadha,"Strength Characteristics of Self-curing ConcreteAmbily,P.S and Rajamane N.P, " Self- curing Concrete an Introduction", Stru ctural Engineering Research Centre, CSIR, Chennai.*
7. *Text book on " Concrete Technology- "Theory and Practice" by M.S.SHETTY*

Gravitation - Flat Power Field

S. A. Orlov

A B S T R A C T

A new principle of origin and the nature of the action of gravity forces are proposed. Forces of universal attraction have plane-symmetrical directions. On this basis, it becomes possible to reconsider certain regularities in natural science. The new principle of gravitation will allow to explain physical paradoxes, to improve methods of scientific research and some technological processes.

Keywords: Theory vortex gravitation, cosmology and cosmogony. Celestial mechanics.

1. INTRODUCTION

As is known, the founder of the theory of world gravitation I. Newton[1] pointed the source of attraction forces to material bodies.

In 1915, 1916 the year of A. Einstein proposed a general theory of relativity[2]. In this theory, gravitational effects are caused not by force interaction of bodies and fields, but by deformation of space-time itself. Deformation is associated with the presence of mass- energy.

These theories have one general condition - the forces of attraction are created by masses of bodies. On the basis of this condition, the conclusion follows: the forces of gravity act centrally symmetrically. That is, they decrease when moving away from the body in the same way, in all directions.

In the author's theory of vortex gravitation[3] it is asserted that the forces of attraction act flat-symmetrically with respect to any cosmic object.

The next chapter describes the basic principle of the theory of vortex gravity.

2. THE THEORY OF VORTEX GRAVITATION

The theory of vortex gravity, cosmology and cosmogony is based on the assumption that gravity, all celestial bodies and elementary particles are created by etheric vortices (torsions). The size of bodies (systems of bodies) and corresponding vortices can differ by an infinite value. The largest etheric vortex that a person can observe is the universal whirlwind, the smallest - the atomic whirlwind.

The orbital velocities of the ether in each vortex decrease in the direction from the center to the periphery, according to the inverse square law. In accordance with the Bernoulli principle, the change in orbital velocities causes an inversely proportional change (increase) in pressure in the ether. The pressure gradient creates the forces of vortex gravity and pushes the substance (body) into the zones with the least pressure, thatis, in the center of the torsion bar. This pattern operates in the same way in ethereal vortices of any size.

The vortex can rotate only in one plane. Consequently, the decrease in the pressure of the ether occurs in the plane of rotation of the ether. Based on Archimedes' law, all bodies are pushed into the plane in which the least pressure occurs. Therefore, the forces of gravity act plane-symmetrically and it is necessary to abandon the classical model of the central-symmetric action of the forces of gravity.

The ether is an excessively little dense gas that permeates all bodies (substances), except for superdense ones. Therefore, the ether can only push these superdense bodies. These superdense bodies are the nucleons of atoms.

In the theory of vortex gravity, the Navier-Stokes equation for the motion of a viscous fluid (gas) was used to determine the pressure gradient in an ether vortex.

$$\left[\frac{\partial}{\partial t} + \vec{v}\cdot \text{grad}\right]\vec{v} = \vec{F} - \text{grad}\, P + \eta\Delta\vec{v} \qquad (1)$$

$\vec{v}$ - velocity vector of the ether,

P - ether pressure,

η - viscosity.

in cylindrical coordinates, taking into account the radial symmetry $v_r=v_z=0$, $v_\varphi=v\,(r)$, P=P (r) the equation can be written in the form of a system

$$\begin{cases} \dfrac{v(r)^2}{r} = \dfrac{1}{\rho}\dfrac{dP}{dr} \\ \eta\cdot\left(\dfrac{\partial^2 v(r)}{\partial r^2} + \dfrac{\partial v(r)}{r\,\partial r} - \dfrac{v(r)}{r^2}\right) = 0 \end{cases} \qquad (2)$$

After the transformations, an equation is obtained for determining the gravitational forces in the ether vortex:

$$F = V_n \times \rho \times \frac{v_e^2}{r} \quad (3),$$

with the following dependence $v_e \sim \frac{1}{r}$ where

V_n - the volume of nucleons in the body that is in the orbit of a torsion with a radius of – r

$\rho = 8.85 \times 10^{-12}$ kg / m^3 - ether density [4]
v_e -- the speed of the ether in the orbit r

r - the radius of the considered orbit of the ether vortex

Let us replace the volume of nucleons in equation (3) by their mass, using the well-known dependence:

$$V_n = m/\rho_n, \quad (4) \qquad \text{where}$$

$\rho_n \sim 1017$ kg / m3 - density, constant for all nucleons.

m - the mass of nucleons in the body

Substituting (4) into (3), we obtain

$$F_g = \frac{m}{\rho_n} \times \rho \times \frac{v^2}{r} = 10^{-28} \times m \times \frac{v^2}{r} \quad (5)$$

Note 1. With the help of vortex gravity equations (3) and (5), gravitational forces can be calculated that act only in the plane of the vortex (torsion). To determine the attractive forces at any point below, additional studies are presented.

3. DETERMINATION OF FORCES OF GRAVITATION IN SPACE

As you know, the planets revolve around the sun in an ellipse with a small eccentricity.

This fact can be explained from the position of vortex gravity. In addition, the elliptical trajectory of the planets will allow us to calculate the gravitational force in a three- dimensional model.

The reason for the appearance of "contraction" of planetary orbits is the inclination of the plane of these orbits to the plane of the solar, gravitational torsion, which is proved by the following conditions.

As is known, the planes of orbital motions of all planets are located with small deviations from each other. Consequently, the planes of the orbits of the planets have an inclination to the plane of the solar gravitational torsion, where the greatest gravitational force acts on each orbit, and they (planets), in their orbital motion, must cross the solar torsion at two points. These points of intersection are the centers of perihelion and aphelion.

In aphelion and perihelion, the force of solar gravity acts on the planets with the largest value in this orbit and, consequently, the orbit of the planet has the maximum curvature. When the planet exits (deflects) from the plane of the solar torsion, the gravitational forces decrease, and the trajectory of the planets "straightens". A similar cycle of variation ofgravitational forces and trajectory of motion is repeated for each planet in each revolution around the Sun. The more the trajectory of revolution of the planet deviates from the central plane of the solar torsion, the more the gravitational forces in these areas decrease. Consequently, the orbit must be more "compressed". A constant, cyclic variation of these forces makes the trajectory of the circulation elliptical.

With significant inclinations and high velocities, the satellite's orbit (meteorite, comet) acquires the trajectory of a hyperbola or parabola. Therefore, the celestial body, once circling the Sun, leaves the gravitational field of the solar torsion forever.

In the theory of vortex gravity [3] it is proved that the squareness of the planet's orbit depends on the angle of inclination of the orbital plane of the considered planet to the plane of the gravitational solar torsion. This dependence has the form:

$$K = \frac{b}{a} = cos\beta$$

K - coefficient of compression of the orbit of the celestial body

a - the length of the semimajor axis of the planet's orbit

b - the length of the minor semiaxis of the planet's orbit

β - the angle of inclination of the planet's orbital plane to the gravitational plane of the solar, etheric vortex (Fig. 1).

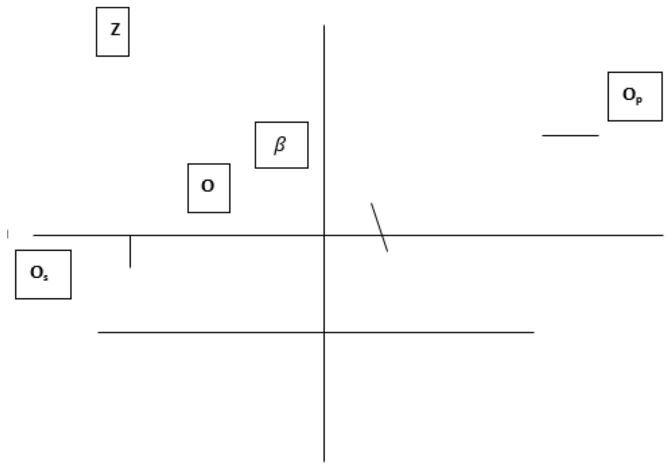


Fig. 1 Cross section of the solar system.

O_s - lateral projection of the orbit of the etheric solar torsion
O_p - lateral projection of the planet's orbit
Z - axis of rotation of the torsion bar
O - projection of the line of intersection of the orbit of planets with a gravitational orbit

Calculations[3] found that the forces of vortex gravity decrease as the distance (s) from the plane of the torsion (in the direction of the torsion axis) is inversely proportional to the cube of this removal - $1/s^3$.

In an arbitrary arrangement of the point under study, the force of the vortex gravity is determined (taking into account Equation 3) as:

$$F_{gv} = F_{gn} \, Cos^3 \beta = V_n \times \rho \times \frac{v_e^2}{r} \times \cos^3\beta \ (7)$$

where
$\cos^3 \beta = Kg$ - the gravitational coefficient
F_{gv} - the force of gravity at an arbitrary point
F_{gn} - gravitational force in the plane of the torsion

The location of the plane of the gravitational torsion in space can be determined by the coordinates of the perihelion and aphelion of all celestial bodies that turn in this plane.

4. PROOF OF PLANE GRAVITATION

In the author's article[3] , the calculation of the gravitational forces acting on the planet Mercury and Pluto was made during their location in the orbit at the apex of the small semi-axes. At these points, the orbits of the planet deviate as much as possible from the plane of the solar gravitational torsion. The calculation was made based on the equation of universal gravitation of Newton and the equation of vortex gravitation (equation 7). The results obtained were compared with centrifugal forces at these points.

Note 1. Centrifugal forces can be calculated as accurately as possible and they are always equal to gravitational forces. Therefore, centrifugal forces can be used as an indicator of the accuracy of the results in determining the gravitational forces.

The distances and velocities of celestial bodies are taken on the basis of the astronomical calendar [4]

1. Pluto

The length of the semi major axis of the Pluto orbit a = 5906.375×10^6 km
The length of the semi-minor axis is = 5720.32×10^6 km

The gravitational coefficient $kg = b^3 / a^3 = \cos^3 \beta = 0.9084$

The distance from the Sun to the summit of the minor semi axis of Pluto's orbit is $d = 5907{,}963 \times 10^6$ km

The radius of curvature at the apex of the small semi axis is $Rb = a^2 / b = 6098.48 \times 10^6$ km

The orbital velocity of Pluto at the apex of the small semi axis is $V_b = 4.581$ km / s

Centrifugal forces at the apex of the small semi axis on the basis of the above characteristics:

$F_c = 0.00344\ M_p$, where M_p is the mass of Pluto

The forces of solar gravity at the same point (according to Newton's classical model)

$F_{gn} = 0.00382\ M_p$ (deviation from centrifugal forces + 11.1%)

The forces of vortex gravity taking into account the gravitational coefficient (equation 7)

$F_{gv} = F_{gn} \times K_g = 0.00382 \times 0.9084 = 0.00347\ M_p$ (discrepancy + 0.87%)

2. Mercury

The length of the semimajor axis of the orbit of Mercury $a = 57.91 \times 10^6$ km

The length of the semi-minor axis $b = 56.67 \times 10^6$ km

The gravitational coefficient $kg = b^3 / a^3 = \cos^3\ \beta = 0.9372$

The distance from the Sun to the summit of the minor semi axis of the orbit of Mercury

$d = 58{,}395 \times 10^6$ km

The radius of curvature at the apex of the small semi-axis is $Rb = a^2 / b = 59{,}177 \times 10^6$ km

The orbital velocity of Mercury at the apex of the small semiaxis is $Vb = 46.4775$ km / s

Centrifugal forces

$F_c = 36.503\ M_m$, where M_m is the mass of Mercury

Gravitational forces:

According to Newton, $F_{gn} = 39.09\ M_m$, (discrepancy + 7.1%)

According to the theory of vortex gravity, $F_{gv} = 39.09 \times 0.9372 \times M_m = 36.63\ M_m$

(discrepancy + 0.35%)

Obviously, the calculation of the theory of vortex gravity is an order of magnitude more accurate than the classical method and in accuracy correspond to the accuracy of astronomical measurements.

5. CONCLUSION

Recognition of the vortex, disk-like nature of gravity will make it possible to explain many paradoxes in natural science, to develop new research in science and technology. Below are presented an insignificant part of the conclusions of vortex gravity, cosmology and cosmogony.

Only the flat-symmetric action of the forces of gravitation proves the structures of the celestial systems.

Planetary systems around any star, satellites around planets, galaxies, all these heavenly systems are flat, disk-like. If the forces of gravity acted in all directions equally (according to Newton's theory), then these heavenly systems would have a spherical shape. Critics can say that gravitation is the same everywhere on the Earth's surface. They should answer that any celestial body is located in the center of the cosmic torsion. The dimensions of celestial bodies are several orders of magnitude smaller than the dimensions of the torsion bars. Therefore, in the center of the torsion, lateral eddies of the ether create a pressure gradient in the axial direction almost the same as in the longitudinal one. Consequently, the forces of gravity almost ascend at the poles, as well as at the equator. It should be noted that accurate measurements have determined: at the poles, the actual gravitational force is less than calculated by the Newton equation. In particular, according to Newton's equation, the force of gravity at the poles of the Earth must be F = 9.86m. Based on geodetic gravimetry, the actual gravity is determined by Fp = 9.83m. This value is 0.3% less than the calculated value, but at the equator theoretical and experimental results are equal.

The unevenness of the decrease in the forces of gravity in the longitudinal and axial directions explains the origin of the tides.

As is known, the terrestrial equatorial plane has an inclination to the ecliptic plane at an angle of 23.5 degrees. The plane of the earth, etheric torsion is located with a slight deviation from the ecliptic. Consequently, each terrestrial point (p. A, Figure 2) crosses the equator twice a day twice the plane of the vortex rotation of the ether, in which the maximum force of terrestrial gravity acts. Consequently, gravitation at any point of the earth changes its strength twice. This fact causes two times the appearance of tides. The explanation of these tides by the gravitational action of the Moon or the Sun is absurd, since any point of the earth's surface is drawn only once per day relative to these celestial bodies. But there are tides twice!

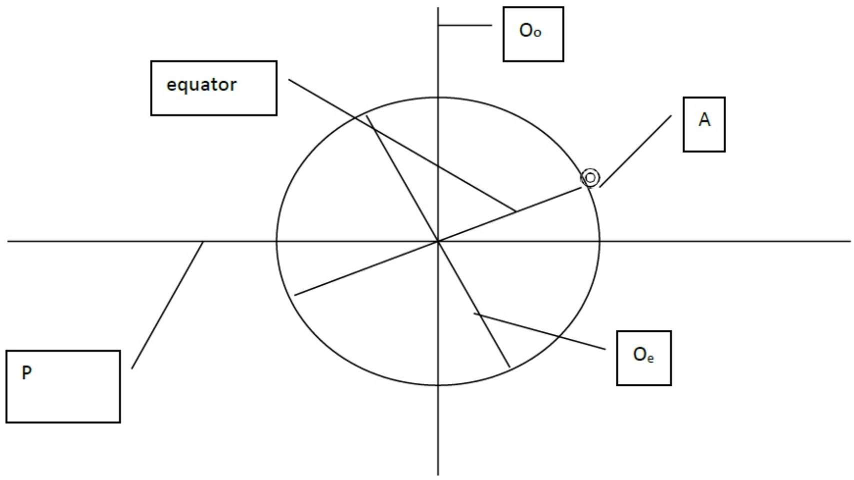


Fig. 2. Flow chart of tides.

P - lateral projection of the plane of the earth torsion.

O_O is the axis of rotation of the Earht's torsion bar.

O_e is the axis of Earth's rotation.

Point A crosses the plane of the earth torsion twice a day.

In the author's article, 5 calculations of physical work have been made, which must be done in a space flight from Earth to the Moon in two versions. The first is a straight, ordinary path inside the Earth's gravitational torsion, the route AS in Fig. 3. The second - bypassing the earth torsion, the ABC route.

The physical work expended by the spacecraft bypassing the earth torsion along the ABC route is 26% less than the work spent on the direct route - the route of the AC.

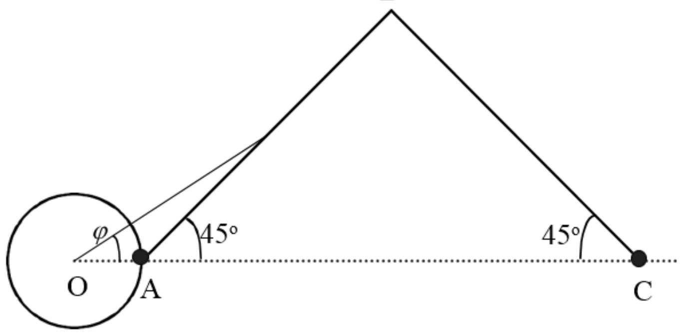


Fig. 3 Scheme of the flight to the moon T. O - Earth, t. C – Moon

Note 2. The aforementioned flat-symmetric action of the forces of gravity can be observed only at a large distance from the center of the torsion, since in the center there are axial vortices of the ether. Therefore, it is impossible to apply equation 7 to determine the forces of gravity on the surface of celestial bodies.

This article offers a very small part of the changes in the scientific understanding of physical phenomena. The theory of vortex gravitation makes it possible to explain many regularities in geophysics, in astronomy, in atomic physics, and in other branches of natural science without contradictions.

REFERENCES

1. *Newton, Sir Isaac (1729). The Mathematical Principles of Natural Philosophy, Volume II Albert Einstein.*
2. *«Die Feldgleichungen der Gravitation». Sitzungsberichte der Preussischen Akademie der Wissenschaften zu Berlin: 844—847.*
3. *S. Orlov. Foundation of vortex gravitation, cosmology and cosmogony. Global journal of science Frontier V A V. A. Atsurovskiy. General ether-dynamics. Energoatomizdat. Moscow, Russia. 1990. Page 278.*
4. *A P Gulyaev. Astronomy calendar. Cosmosinform. Moscow, Russia. 1993. Page 285.*
5. *Sergey Orlov On Optimal Trajectory in Space Flight. American Journal of Aerospace Engineering Volume 3, Issue 2, April 2016, Pages: 6-12*

Evaluation of Mechanical Properties And Flexure Behaviour of High Performance Hybrid Fibre Reinforced Concrete – A Review

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ABSTRACT

High-performance concrete (HPC) is a material frequently used in the building industry due to its durability. Concrete technology has developed at a rapid pace over the last two decades and the material performance has been significantly improved. Now a day, there are numerous types of fibres made of different materials that are of different geometric properties. With each type of fibre certain properties of concrete can be improved. In order to improve mechanical properties, especially the tensile and flexural strengths and long-term concrete shrinkage, steel fibres' are usually used. One of the recent concepts is the hybridization of fibres, the optimum combination of several kinds of fibres with different properties to create a complex composite with a very high resistance to cracking in a wide range of crack width. A lot of research revealed that a hybrid of steel and polypropylene fibre in concrete exhibits composite advantages of the two-fibre material properties, improves the interface condition between cement and aggregate, enhances the medium continuity of concrete, and constraints the occurrence and development of concrete cracks. Present study focussed on the rational development of researches on hybrid fibres from past decades and objectives of future enhancement.

Keywords: Review on hybrid fibre RC, properties study, future applications

1. INTRODUCTION

High - strength concrete is particular where reduced weight is significant or where architectural considerations require smaller load-carrying elements, high strength concrete helps to get more well-organized floor plans through smaller vertical members and has also often established to be the most economical alternative by reducing both the total volume of concrete and the amount of steel required for a structural members [1]. However, high strength concrete when subjected to short term or sustained loads tends to be brittle. This performance of high strength concrete raises questions about the application of the material to structures, mainly in earthquake regions. Addition of fibres in concrete improve the tensile characteristics by inhibiting crack growth and increase in toughness or energy absorption capacity, flexural strength, fatigue resistance and ductility [2,3]. Various types of fibres were used in concrete such as metallic fibres, polymeric fibres, mineral fibres, and naturally occurring fibres, among these steel fibres are giving better performance due to their high modulus of elasticity and tensile strength. Concrete with steel fibres have been generally used in the building industry applications such as industrial and airport pavements, reinforcement of projected concrete, and precast elements.

2. OBJECTIVES:

- To review the different researches made on hybrid fiber reinforced concrete.
- To understand the behaviour of HFRC with different combinations.
- To study the behaviour of HFRC by using steel fibres.
- To study the behaviour of HFRC with Polymer fibres.

3. LITERATURE REVIEW:

[1] W. Sun, H. Qian, H. Chen,(2000).Durability is the ability to last a long time without significant deterioration. Hybrid fiber reinforced concrete (HFRC) proves to be durable material, which is effective in resisting the damage caused due to freezing and thawing due to synergistic performance of hybrid fibers. It has been concluded that the performance of hybrid fibers in concrete is better than that of mono fiber concrete for improved durability in resisting the destructive effect of freezing and thawing and also for strength enhancement.[2] Banthia, N., Yan, C., Bindiganavile, V. (2000).To develop High Performance Fibre Reinforced Concrete(HPFRC). Towards an efficient utilization of binders and fibres in HPFRC, the modified Andresen & Andersen particle packing model and the hybridization design of fibers are utilized. The HPFRC mixtures with hybrid fibres have higher strengths than those with a single type of fibres. The macro-fibres (hooked steel fibres) can also be utilized to produce HPFRC, with good mechanical properties. [3] Qian, C.X. and Stroeven, P. (2000).This study report deals with the reinforcing efficiency of hybrid fibres in the low volume fly ash concrete up to 30% replacement of cement. Micro mechanical action of hybrid fibres in fly ash based concrete will be improved with respect to different percentage of steel and polypropylene fibre addition. The optimum level of fly ash replacement should be between 10 to 30% in order to obtain maximum strength of the concrete. If fly ash replacement level up to 60%, concrete gains its strength only after 90 days of curing The increase in percentage of steel fiber results only in increase of tensile strength. [4] Skazlić, M. (2001).a review on the high performance high volume fly ash concrete reinforced with hybrid fibers. tried to substitute fly ash for cement which generally leads to lower strength. it is clear that steel fiber (high modulus fiber) which is stronger and stiffer, improves the concrete strength, while polypropylene fiber has the capacity to strengthen brittle cementitious materials and is more flexible and has the property to retain heat for a prolonged time which leads to improved toughness, and strain capacity in the post cracking section and retard early cracks.[5] Naaman, A.E., and Reinhardt, H.W., (2001) The described materials were specifically developed for application as a transition layer: a repair layer that constitutes the stressed chord of reinforced concrete beams strengthened in flexure with carbon fiber reinforced polymers

(CFRP). the hybridization process is an interesting alternative for application in the recovery of tensile bottom chord of beams, once the addition of micro fibers to the steel fibres' increased the tensile stress in flexure and increased the flexural tenacity of the cement-based mortar and microconcrete composites. [6]Alwan JM, Naaman AE, Hansen W.(2002) Pull The use of high performance composite fibers allows for the improvement of the mechanical properties of cement composites. Mechanical properties of such composites are determined predominantly by the interface properties between the fiber and cementations' matrix.Composites using single-fiber pull-out tests. For this purpose, the study presents the characteristics of both fiber-matrix interfacial properties and fiber rupture. The results of these tests allow specific design parameters to be evaluated quantitatively. [7]Y. Liu, W. Qiu, D. Li, (2003).Polypropylene Fiber Reinforced Concrete is an embryonic construction material which can be described as a concrete having high mechanical strength, Stiffness and durability. Polypropylene fibers are versatile and widely used in many industrial applications such as ropes, furnishing products, packaging materials etc.Polypropylene Fiber reinforced Concrete is used in roads and pavements, drive ways, Overlays and toppings, ground supported slabs, Machine foundations.[8] Chanvillard G, Rigaud S.(2003a model-based analysis of the risk of early age cracking in structures made of High Performance Concrete (HPC). First, we summarize the background works on modellingHPC at early age with emphasis on the thermodynamics hypothesis of partial decoupling which substantially simplifies the application and calibration of the model. The effect of hydration heat can be critical for HPC structures with size larger of 20-30 cm, which is the critical diffusion length; The concept of level of loading was used as indicator of risk of early age cracking. Furthermore, a preliminary probabilistic approach was presented as powerful tool to identify the impact of material parameters on the risk of cracking. [9] Banthia, N., Nandakumar, N. (2003).to use of different fiber as reinforcement in concrete for a greater durability, workability and reduction in crack. The present work is concerned with the compressive strength of FRC specimens (132 cubes) with 90 days of normal water curing and 90 days curing in sulphate& chlorideThe fiber orientation plays an important role to determine the compressive strength, which depends on the mixing. FRC controls the micro cracking, shrinkage and deformation under load much better than plain concrete. [10]Song PS.(2004).The various strength properties studied are cube and cylinder compressive strength, split tensile strength, modulus of rupture and post cracking performance, modulus of elasticity, Poisson's ratio, and strain corresponding to peak compressive stress.The maximum increase in the compressive strength, modulus of elasticity, and Poisson's ration due to the addition of steel fibers was found to be quite small less than 10% in various grades of concrete 35, 65, and 85 MPa. The maximum increase in the strain corresponding to the peak compressive strength was found to be about 30% in various grades of concrete 35, 65, and 85 MPa.[11] RILEM PRO (2004)to study the effect of fibre hybridization on the strength characteristics such as compressive strength, split tensile strength, and water permeability of steel fibre reinforced concrete (SFRC) are presented.

Combinations of steel fibres of different lengths and plain concrete in hardened state have been investigated. Tests such as compressive strength, split tensile strength, and water permeability were conducted on hardened concrete after 7, 28, 90, and 120 days of curing. [12]N. Banthia, R. Gupta,(2004)Nylon fiber is not an absolutely new material, it is successfully applied in such fields as mostly found in garment interlinings, tooth brush, Fishing lines, Nets and building structures. Finally we have come to a conclusion that Nylon Fibre Reinforced Concrete has far better strength than normal concrete. Nylon Fibre Reinforced of 1%, 2%, 3% and Normal Concrete and also found that adding 1% Nylon of total volume of concrete achieves more strength than that of normal concrete.[13] Lawler J, Zampini D, Shah S. Micro (2005)Since many decades efforts have been made to reduce the brittleness of cementations' materials by the use of micro and macro fibers of different mechanical, geometrical and physical properties. Maximum load bearing capacity (peak load), residual flexural strength and flexural toughness unreinforced matrix are significantly increased by the addition of metallic fibers. [14] J.A.O. Barros, E. Pereira, A. Ribeiro, V. Cunha,(2005) experimental study and technical details of the suggested technique along with those of the traditional sandwich panels are presented. The experimental work is conducted on full scale specimens to verify the applicability and efficiency of the proposed method. Results indicated that the ultimate loads, failure modes, and load deflection relationships of the proposed walls are greatly improved by using the suggested technique. A large increase is observed of yield and ultimate load-carrying capacities of the proposed technique specimen compared to reference sandwich panel ones.[15] Wang C, Yang C, Liu F, Wan C, Pu X.(2005)The construction of high-rise buildings and mega projects around the world, and the increasing demands of owners and designers have led to the increasing demand on High Strength Concrete (HSCan intensive study has been made on the development of High Strength Concrete. Three different concrete mixes have been used to get High Strength Concrete. Cubes, cylinders and prisms have been cast using this three different mixes and their properties in fresh and hardened states have been experimentally found out.[16]Markovic I.(2006) Hybrid Fiber Concretes (HFC) are newly developed cement composites, whose main characteristic is utilization of different types of steel fibres in high-strength mortar mixtures. Although the flexural behavior was very superior, the determination of uniaxial tensile behavior is necessary to provide a basis for design. The uniaxial tensile behavior of a number of mono - and hybrid-fibre reinforced concretes was estimated. Maximum applied fibre volume was 2 vol.-% (160 kg/m3). Tensile tests were performed on unnotched and on a couple of notched “dogbone” specimens.[17] Habel K, Viviani M, Denarie E, Bruhwiler E.(2006)this paper investigate the effect of steel fiber (volume fraction and aspect ratio) on the mechanical properties of high performance concrete such as, Compressive strength, modulus of elasticity, Poisson's ratio, flexural strength and tensile strength. his research show that it is possible to produce HPFRC using available local materials that if they are carefully selected. Such concretes can be produced with ordinary Portland cement, silica fume, steel fibers, super plasticizer, fine sand and basalt with ratio as discussed before.[18] Banthia, N. and Gupta, R., (2006) .Plastic shrinkage cracks are especially harmful on slabs. One of the methods to reduce the adverse effects of shrinkage cracking of concrete is by reinforcing concrete with short randomly distributed fibers. A significant reduction in water bleeding is observed for concrete series B compared to concrete series A for all concretes. first crack initiation time for series B plain concrete is two times higher compared series A plain concrete. [19] Naaman AE. (2007) the fiber material (steel, synthetic, natural organic) or the level of performance, a general, It is based on the response of the composite under tensile loading, which can be described as either strain softening after first cracking, or strain hardening. This impetus may be partly due to fundamental research, better understanding of the reinforcing mechanisms of FRC composites, the need for materials with particular properties, developments in advanced materials, economic competitiveness, and global circumstances. A solid foundation has thus been built.[20] M. di Prisco (Ed.),(2007).The lightweight, high strength and corrosion resistance of fiber reinforced polymers (FRP) make them ideally suited for quick and effective structural repairs. The motivating premise of all the repair options considered was that external confinement in the form of jacketing could alter favorably the process of corrosion by slowing down the rate of the corrosion reaction, and imparting ductility and strength to the affected structural element. FRP wraps, being strong and corrosion-resistant, proved very effective as jacketing material.[21] Kim DJ, El-Tawil S, Naaman AE.(2007) the study is to study the effect of glass fibre and steel fibers in the concrete. In the present work the strength studies are carried out to compare the glass and steel fiber concrete. In compressive strength, flexural strength and split tensile strength, the addition of Steel fiber the strength is increasing linearly, but in glass fiber up to 1% it is increasing and from 2% it is decreasing. It is concluded that the strength is increasing while increasing the percentage of steel fiber. [22] Kim DJ, Naaman AE, El-Tawil S,(2007)a steel fibers in a concrete matrix improves all the mechanical properties of concrete, especially tensile strength, impact strength, and toughness. The resulting material possesses higher tensile strength, consolidated response and better ductility. The suggested equation correlates the split tensile strength of steel fiber reinforced concrete with concrete compressive strength and fiber reinforcement index Concrete compressive strength, fiber content and the fiber aspect ratio are the major effectual parameters in specifying the tensile strength of fiber concrete. [23]C. Yang, C. Huang, Y. Che, B. Wang,(2008) The effect of addition of mono fibers and hybrid fibers on the mechanical properties of concrete mixture is studied in the present investigation. Steel concrete mixture as mono fibers and then they were added together to form a hybrid fiber reinforced concrete. It is evident from the present investigation that the hybridization of fibers proves to be better as compared to mono fibers. The improved mechanical properties of HFRC would result in reduction of warping stresses, short and long term cracking and reduction of slab thickness.[24] Graybeal B, Davis M.(2008)Mixing of horsehair and straw with the clay to form floor and bricks was one of the earliest example in which fiber was utilized to strengthen a brittle matrix. then, and papers have been published on the use of various fibers in cement-based material. Workability of the fresh mix is adversely affected by the addition of fibers and further decreases by increasing the fiber volume fraction. No particular trend is observed in compressive strength due to addition of fibers. Flexural and tensile strength, ductility, drying shrinkage and toughness of the material is usually benefited by the addition of fibers.[25] Jungwirth J, Muttoni A.(2008) As continued research on High Performance Concrete (UHPC) becomes more readily available, researchers are becoming increasingly interested in developing new structural applications for the material. [26] Sivakumar A.(2009)Concrete is the mostly used construction material in the world but there is a disadvantage of concrete that it is week in tension. This results to the brittleness of concrete. This property is not desirable for any kind of construction so there is requirement of tensile reinforce. Steel fiber reinforced concrete is basically defined as a composite material which consist of steel fiber of specific characteristics like random distribution and specific size and volume as compare to the conventional reinforced steel bars the steel fibre are thin, short and randomly distributed in the concrete.[27] J. C. Walraven, (2009)Sustained post cracking tensile resistance is a fundamental mechanical characteristic of high-performance fiber-reinforced concrete This research program developed a simple, reliable direct tension test (DTT) method that can generate the uniaxial tensile mechanical response for both cast and extracted samples. A foundation from which a reliable, practical method to directly capture the uniaxial tensile stress-strain response of HPFRC can be created. The developed test method meets critical test requirements, including the ability to be completed relatively quickly on either cast or extracted specimens through the use of commercially available testing equipment.[28] M. di Prisco, G. Plizzari, L. Vandewalle, (2009). A Fiber Reinforced Concrete (FRC) is a composite material consisting of cement based matrix with an ordered or random distribution of fiber which can be steel, nylon, polythene etc. Development in technology enhances not only human comforts but also destroy the eco-system. Fiber Reinforced Concrete is generally made with high M40 grade cement content & low water content. Steel Fiber 1.5% addition improves ductility of concrete & its post-cracking load carrying capacity. Increases the cube compressive strength 40.00 Mpaconcrete in 7 days The most important contribution of fibre reinforcement in concrete is not to strength but to the flexural strength 18% concrete materials. [29] F. Bencardino, L. Rizzuti, G. Spadea, R. N. Swamy,(2010) Concrete is characterized by brittle failure, the nearly complete loss of loading capacity, once failure is initiated. This characteristic, which limits the application of the material, can be overcome by the inclusion of a small amount of short randomly distributed fibers and can be practiced among others that remedy weaknesses of concrete, such as low growth resistance, high shrinkage cracking, low durability .Fiber addition improves the strength parameters of concrete. This may be due to the high energy absorbing capacity of fibers. Fracture properties show an increasing variation with an increase in fiber content from 0.5%to 1% due to the crack resisting property of steel fibers.[30] S. P. Singh, A. P. Singh, V. Bajaj, (2010) investigation conducted study the effect of fiber hybridization on the strength characteristics such as compressive strength, split tensile strength, and water permeability of steel fiber reinforced concrete (SFRC) are presented. Properties of HSFRC containing different combinations of steel fibers of different lengths and plain concrete in hardened state have been investigated. Tests such as compressive strength, split tensile strength, and water permeability were conducted on hardened concrete after 7, 28, 90, and 120 days of curing. [31] Ryu GS, Kang ST, Park JJ, Koh GT. (2010)The material attributes are understood by studying the stress strain behavior of UHPC cylinders under uniaxial compressive loading. The load –crack mouth opening displacement (cmod) of HPC beams, flexural strength and fracture energy was evaluated using third point loading test.The stress strain characteristic shows that pre peak region has linear ascending portion and strain at peak stress increases with increase in strength and reinforcement index. The post peak curve is strongly dependent on the fiber type and fiber content and it is almost as steep as ascending curve for lower fiber contents and may be more gradually sloping for the higher fiber contents.[32] Hamad BS, Abou Haidar EY(2011). The effect of fibers was not observed in enhancing the pre-crack performance of the test specimens, whereas the ultimate bond strength and post peak bond strength performance increased significantly. The ultimate bond strength is found to be strongly affected by the compressive strength rather than fiber volume. Brittle failure was more pronounced in specimens with bigger sizes. The irregular post peak profile of load-slip curve resulting from this brittleness changed to smooth consistent one as the fiber dosage increased Fibers were found to influence both the ultimate bond strength and post maximum bond strength.[33] Wille K, Naaman AE, Parra- Montesinos GJ. (2011). Advances in the science of concrete materials have led to the development of a new class of cementations' composites, namely ultra-high performance concrete (HPC). The mechanical and durability properties of HPC make it an ideal candidate for use in developing new solutions to pressing concerns about highway infrastructure deterioration, repair, and replacement Whether used to facilitate accelerated construction, lengthen span ranges, or rehabilitate substandard infrastructure, UHPC can facilitate the development of unique solutions to existing challenges. As with any new material, utilization will grow as innovative applications are developed and market demand intensifies.[34] El-Tawil S, Parra-Montesinos G.(2011)The reported experimental program at the University of Illinois has been conducted to further understand the behavior of HPFRCC under general uniaxial and biaxial stress states, such as would be expected at various key locations in a coupling beam. In the future, completion of tension tests will further the understanding of the behavior of this sort of HPFRCC and provide more comprehensive knowledge about the material and its fully biaxial behavior. Such thorough understanding of HPFRCC has many implications, including making computer modeling and the extension of the material's use to more large-scale structural applications possible.[35] X. K. Li, L. Sun, Y. Y. Zhou, S. B. Zhao, (2012)Polypropylene Fiber Reinforced Concrete is an embryonic construction material which can be described as a concrete having high mechanical strength, Stiffness and durability. By utilization of Polypropylene fibers in concrete not only optimum utilization of materials is achieved but also the cost reduction is achieved. Polypropylene fibers reduce the water permeability, plastic, shrinkage and settlement and carbonation depth. Workability of concrete decreases with increase in polypropylene fiber volume fraction. However, Polypropylene fibers enhance the strength of concrete, without causing the well known problems, normally associated with steel fibers.[36] Corinaldesi V, Moriconi G.(2012) The expected outcome which is the strength of hybrid fiber reinforced concrete is higher than the strength of normal concrete did achieved. So, further research need to be carried out with some adjustments of methods or materials. The rate of strength gain for 7 days strength of HFRC is very high as compared to conventional concrete and hence concludes that HFRC has high early Strength and continued strength development. As % of fiber increases the split tensile strength also increases. Workability drastically decreases when coconut fiber content is increased in concrete.[37] Deeb R, Ghanbari A, Karihaloo BL.(2012)the HSC mix to become a self- compacting mix will enable the inclusion of steel fibers without sacrificing its workability. In this study, the behavior of eight axially loaded medium scale columns cast with ultra-high-strength fiber-reinforced self-compacting concrete is investigated.At high fiber volume fraction the high deformability of the concrete activated the confinement exerted by the stirrups. d. For reducing the spacing between the stirrups did not significantly improve the confinement.[38] Ramezanianpour, A.A. Esmaeili, M., Ghahari, S.A., and Najafi, M.H. (2013).In this study Various mixture of class C fly ash in ratio of 30%, 40% and 50% was used in the concrete mix containing polypropylene fiber of volume fractions of 0.15,0.20,0.25,0.30 was used for all fly ash concrete mixes. Each series consists of cubes, cylinders and prisms as per IS standard. Compressive strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in compressive strength as compared with normal plain concrete (without fibers) Splitting tensile strength of concrete increases gradually by addition of Polypropylene fiber from 0.15% to 0.30%. There is increase in splitting tensile strength as compared with normal plain concrete (without fibers).[39] Tran TK, Kim DJ.(2014)In this paper study of M50 grade concrete ... on cubes, cylinder and beams made of Quarry Dust with 5% steel fiber, and polymer 2.3% we have been using M50 Grade concrete for casting of segments Investigation is done on M30, and M50 mix using fly ash as partial replacement by weight of cement. Experimentation is carried out to find the compressive strength36.54 Mpa, flexural strength of the 14Mpa concrete blocks. Experimentation is also carried out analysis the production cost of concrete paving blocks by using Waste Material. [40] Patel, P.A., Desai, A.K., Desai, A.J. (2015)Plain concrete has low tensile strength, less ductility, destructive and brittle failure. In order to improve these properties of plain concrete, an attempt has been made to study the effect of addition polypropylene fiber in ordinary Portland cement concrete. The addition of fibers into the concrete mixture marginally improves the compressive strength at 28 days but there is 51.05% increase in flexural strength with the addition of 0.25% fiber in concrete. It is observed from the experimental results and its analysis, that the compressive strength of concrete and flexural strength of concrete increases with addition of fibers. [41]S. Kiruthika, Dr.G.S. Thirugnanam (2016).The effect of addition of mono fibres and hybrid fibres on the mechanical properties of concrete mixture made of M30 grade was studied in the present investigation. In this study, the optimum addition of fibres obtained from previous reviews such as Steel fibres of 1% by volume of concrete and banana fibres of 0.5% by weight of cement was added individually to the concrete mixture as mono fibres and then they were added together to form a hybrid fibre reinforced concrete. Mechanical properties such as compressive 0.85 Mpa split tensile and flexural strength 0.92 were determined. The results show that hybrid fibers improve the compressive strength marginally as compared to mono fibers. Whereas, hybridization improves split tensile strength and flexural strength noticeably.

4. RESULTS AND DISCUSSIONS

References	Year	Study	Results
Qian, C.X Stroeven, P.[3]	2000	deals with the reinforcing efficiency of hybrid fibers	Maximum strength of concrete-increase 30%
Naaman, A.E Reinhardt, H.W[5]	2001	Developedforapplication as a transition layer of reinforced concrete.	The addition of microfibers to the steel fibres' increased the tensile stress in flexure and increased
Banthia, N.,Nandakumar, N.	-2003	Use of different fiber as reinforcement in concrete for a greater durability, workability and reduction in crack	FRC controls the micro cracking, shrinkage and deformation under load much better than plain concrete.
Lawler J, Zampini D, Shah S. Micro	-2005	materials by the use of micro and macro fibers of different mechanical, geometrical and physical	Maximum load bearing capacity (peak load), residual flexural strength and flexural toughness unreinforced matrix are significantly increased
J.A.O. Barros, E. Pereira, A. Ribeiro ,	2005	To study and technical details of the suggested technique along with those of the traditional sandwich panels are presented.	A large increase is observed of yield and ultimate load-carrying capacities of the proposed technique specimen compared to reference sandwich panel ones.
Kim DJ, El-Tawil S, Naaman AE	-2007	the present work the strength studies are carried out to compare the glass and steel fiber concrete	The addition of Steel fiber the strength is increasing linearly, but in glass fiber up to 1% it is increasing and from 2% it is decreasing.
Patel, P.A., Desai, A.K., Desai, A.J.	-2015	To study the effect of addition polypropylene fiber in ordinary Portland cement concrete.	Fibres improve the compressive strength and 51.05% increase in flexural strength.

Table-1 Comparison of mechanical properties of HFRC based on the different material compositions.

References	Nomenclature	Grades	Cement (Kg)	water (Kg)	Coarse Aggregate (Kg)	Super plasticizers (Kg)	Compressive strength (Mpa)	Flexural strength (Mpa)
Jungwirth J, 2008)	HPC1	M40	515	150	1000	5.3	40.86	19
Abou Haidar EY(2011)	HPC2	M45	489	145	950	4.8	38.32	16
H.W.,(2001)	HPC3	M50	472	130	850	4.75	36.54	13
KohGT.(2010)	HPC4	M55	443	125	760	3.8	44.51	11
Desai, A.J. - 2015	HPC5	M60	418	110	680	3.75	53.34	9

DISCUSSIONS:

The results of the present investigation are presented in this section. Table 1 gives compressive strength of M40, M45, M50, M55 and M60 grades of concrete with various levels of replacement of cement by fly ash.

For M60 grade of concrete, the compressive strength is increased when compared to normal concrete, replacement of cement.

It can be stated that at M60of replacement of cement by fly ash, there is considerable increase in strength properties. Hence, M60 replacement can be considered as optimum replacement level to get enhanced strength. Also, it can be concluded that replacement of cement by fly ash is not suitable for higher grades of concrete such as M50. It results in decreased value of strength properties for the selected replacement levels of cement by fly ash.

5. CONCLUSIONS AND FUTURE SCOPE

- Fibres increasing the strengthening parameters, but the mix proportions variance have to be study for better optimistic results.
- Most of steel and glass fibres are researched to improve strengthening parameters like compressive and flexural strength.
- Polymer fibre increases strength approximately 50% with the addition of 0.25% as per the nearest work done.
- Hybrid fibres have to evaluate with different proportionate in a practical way to checkout for optimal results as future approaches.
- Finally concluded that most of the hybrid fibre mixes with HSC to check the durability applications for future enhancement.

REFERENCES:

1. Alwan JM, Naaman AE, Hansen W.(2002) Pullout work of steel fibers from cementitious composites: analytical investigation. Cement Concrete 13(4):247–55.

2. Banthia, N. and Gupta, R., (2006) . "Influence of Polypropylene fiber geometry on plastic shrinkage cracking in concrete". Cement and Concrete Research. 367 1236-1267.
3. Banthia, N., Nandakumar, N. (2003). "Crack Growth Resistance of Hybrid Fiber Reinforced Cement Composites" Cement & Concrete Composites, 25, 3-9.
4. Banthia, N., Yan, C., Bindiganavile, V. (2000). "Development and Application of High Performance Hybrid Fiber Reinforced Concrete" Proceedings of the Fifth International Rilem Symposium on Fibre-Reinforced Concrete, 471-480.
5. C. Yang, C. Huang, Y. Che, B. Wang,(2008) Mechanical properties and impermeability of h ybrid fiber reinforced concrete, Journal of Building Materials, 1 89–93.
6. Chanvillard G, Rigaud S.(2003). Complete characterization of tensile properties of DUCTAL_ UHP-FRC according to the French recommendations. In: Proceeding of fourthinternational workshop on high performance fibre reinforced cement composites (HPFRCC4). Ann Arbor, MI, USA;
7. Corinaldesi V, Moriconi G.(2012) Mechanical and thermal evaluation of Ultra High Perfor mance Fiber Reinforced Concretes for engineering applications. Construction Build Mate r 2012;26:289–94.
8. Deeb R, Ghanbari A, Karihaloo BL.(2012) Development of self-Compacting high and ultra high performance concretes with and without steel fibres. Cement Concrete Composite ;34:185–90.
9. El-Tawil S, Parra-Montesinos G.(2011) Behavior of high performance fiber reinforced cement composites under multi-axial compressive loading. Cement Concrete Compos 32(1):62–72.
10. F. Bencardino, L. Rizzuti, G. Spadea, R. N. Swamy,(2010) Experimental evaluation of fiber reinforced concrete fracture properties, Composites Part B: Engineering, 411,17– 24, doi:10.1016/ j.compositesb.2009.09 .002.
11. Graybeal B, Davis M.(2008) Cylinder or cube: strength testing of 80 to 200 Mpa (116to 29 ksi) High-Performance-Fiber-Reinforced Concrete. ACI Mater J2008;105(6):603–9.
12. Habel K, Viviani M, Denarie E, Bruhwiler E.(2006) Development of the mechanicalproperties of an High Performance Fiber Reinforced Concrete (HPFRC).Cement Concrete , 36(7):1362–70.
13. Hamad BS, AbouHaidarEY(2011). Effect of steel fibres' on bond strength of hooked bars in high-strength concrete, Journal of Materials in Civil Engineering.; 23(5):673–81.
14. J. C. Walraven, (2009) High performance fiber reinforced concrete: progress in knowledge and design codes, Materials and Structures, 42 9, 1247–1260, doi:10.1617/s11527-009- 9538-3
15. J.A.O. Barros, E. Pereira, A. Ribeiro, V. Cunha,(2005) (Self-compacting steel fiber reinforced concrete for precasted sandwich panels experimental and numerical research, Proceedings of international workshop on advanced fiber reinforced concrete, Bergamo, pp:169–80.
16. Jungwirth J, Muttoni A.(2008) Structural behavior of tension members in High Performa nce Concrete. In: International symposium on ultra high performance concrete, Kassel; pp.553–46.
17. Kakooei S.(2013) The effects of polypropylene fibers on the properties of reinforced concrete structures. Construction and Building Materials.; 27(1): 73–7.
18. Kim DJ, El-Tawil S, Naaman AE.(2007) Correlation between single fibre pull out behaviour and tensile response of FRC composites with high strength steel fiber. In: Proceeding of fifth international symposium on high performance fibre reinforced cementations composites, Mainz, Germany; pp. 67–76.
19. Kim DJ, Naaman AE, El-Tawil S,(2007) High tensile strength strain-hardening FRC composites with less than 2% fiber content. In: Fehling E, Schmidt M, St urwald S, co edit ors, Proceeding of second international symposium on high performance concrete, 169– 76.
20. Lawler J, Zampini D, Shah S. Micro (2005) fiber and Macro fiber hybrid fiber- reinforced concrete. Journal of Materials in Civil Engineering. 2005; 17(5): 595–604.
21. M. di Prisco (Ed.),(2007).Fibre-reinforced concrete for strong, durable and cost-saving structures and infrastructures, Starry link, Brescia
22. M. di Prisco, G. Plizzari, L. Vandewalle,(2009). Fibre reinforced concrete: new design pers pectives, Materials and Structures, 42
23. Markovic I.(2006) High-Performance Hybrid-Fibre Concrete– Development and Utilization, Ph.D. thesis, TechnischeUniversität Delft;
24. N. Banthia, R. Gupta,(2004) hybrid fiber reinforced concrete (HFRC): fibre synergy in high strength matrices, Materials and Structures, 707–716
25. Naaman AE.(2007) High performance fiber reinforced cement composites classification and applications CBM–C1 International workshop. Karachi Pakistan. 2007. p.389–400.
26. Naaman, A.E., and Reinhardt, H.W.,(2001) "High Performance Fiber Reinforced Cement Composites, Proceedings of International Conference on Concrete Engineering and Technology, Institute of EngineersmMalysia,
27. Patel, P.A., Desai, A.K., Desai, A.J. (2015) "Evaluation of Engineering Properties for Polypropylene Fiber

Reinforced Concrete". International Journal of Advanced Engineering Technology, 31 42-45.
28. Qian, C.X. and Stroeven, P. (2000). "Development of Hybrid Polypropylene-Steel Fibre- Reinforced Concrete" Cement and Concrete Research, 30. 63 – 69.
29. Ramezanianpour, A.A. Esmaeili, M., Ghahari, S.A., and Najafi, M.H. (2013). "Laboratory Study on the Effect of Polypropylene Fiber on Durability Physical and Mechanical Characteristic of Concrete for Application in Sleepers". Construction and Building Materials. 44 411–418.
30. Ryu GS, Kang ST, Park JJ, Koh GT.(2010) Evaluation of flexural performance in HPC(High Performance Concrete) according to placement methods. Key EngMater 417–8. p. 581–4.
31. S. P. Singh, A. P. Singh, V. Bajaj,(2010) Strength and flexural toughness of concrete reinforced with steel-polypropylene hybrid fibers, Asian Journal Of Civil Engineering (Building and Housing), volume 4, 495–507
32. Sivakumar A.(2009) Mechanical properties of high strength concrete reinforced with metallic and non-metallic fibres. Cement and Concrete Composites.; 29(8):603–8.
33. Skazlić, M. (2001). High Performance Hybrid Fibre-Reinforced Concretes, Master's Thesis at the Faculty of Civil Engineering, University of Zagreb, Zagreb
34. Song PS.(2004). Mechanical properties of high-strength steel fiber reinforced concrete, Construction and building materials. Elsevier. 2004; 18(9):669–73.
35. Sotoudeh MH. (2013) Effects of waste steel fibres' on strength and stress-strain behaviour of concrete incorporating silica nano powder. Indian Journal of Science and Technology. Nov; 6(11): 5411–7.
36. Tran TK, Kim DJ.(2014) High strain rate effects on direct tensile behavior of high performance fiber reinforced cementitious composites. Cement & Concrete Composite pp:186–200.
37. W. Sun, H. Qian, H. Chen,(2000). The effect of the combination of hybridfibers and expansive agent on the physical properties of cementations composites, Journal of the Chinese Ceramic Society, 2 (2000), 95–99.
38. Wang C, Yang C, Liu F, Wan C, Pu X.(2005)Preparation of High Performance Concrete with common technology and materials. Cement & Concrete Composite;34:538–44.
39. Wille K, Naaman AE, Parra-Montesinos GJ.(2011). high performance concrete with compressive strength exceeding 150 MPa (22 ksi): a simpler way. ACI Material Jan 2011; 108(6):46–54.
40. X. K. Li, L. Sun, Y. Y. Zhou, S. B. Zhao, (2012) A Review of Steel-polypropylene Hybrid Fiber Reinforced Concrete, Applied Mechanics and Materials, 238 ,26-32 .

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