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"EXPERIMENTAL STUDY ON STRENGTH CHARACTERISTICS OF CONCRETE WITH PARTIAL REPLACEMENT OF CEMENT BY HYPO SLUDGE"

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Abstract: The increasing amount of wastes is a concerning reality that has arose the sustainability issues for the environment. Large amount of hypo sludge (from paper mill industry). Are generated around 300 million tons annually. Their disposal generally by landfills leads to environmental pollution. Also, the production of cement accounts the global warming by releasing carbon dioxide. The present project work is directed towards developing low cost concrete from paper industry waste. It is carried out with M30 grade concrete with W/c ratio of 0.45 as a control specimen and hypo sludge is replaced in different %ages such as 10%, 20%, and 30% by weight of cement. Cubes of 150mm x 150mm size and Cylinders of 100mm dia and 200mm height, are casted for conventional concrete and RPH (Replacement of hypo sludge by weight of cement) test specimen respectively. Test was conducted to study the mechanical properties of concrete, such as compressive strength and split tensile strength. The curing period should be 7, 14, 21 and 28 days.

Keywords: cement, hypo sludge, M30 grade concrete, Compressive strength, Workability, Split tensile Strength

I. INTRODUCTION

Concrete, is most widely used man made construction material and is the largest production of all the materials used in construction industry. Concrete is basically made of cementitious materials which have to properly bind themselves together, as well as with other materials to form a solid mass. Concrete or mortar is made up of cement, water and aggregates (Coarse and Fine Aggregate) and sometimes with necessary admixtures. Concrete has attained the status of a major building material in all the branches of modern construction. It is difficult to point out another material of construction which is as variable as concrete. Concrete is the best material of choice where strength, durability, impermeability, fire resistance and absorption resistance are required. Compressive strength is considered as an index to assess the overall quality of concrete and it is generally assumed that an improvement in the compressive strength results in improvement of all other properties. Hence strength investigations are generally centered on compressive strength. Even though concrete mixes are proportioned on the basis of achieving the desired compressive strength at the specified age, flexural strength often play a vital role in concrete making. Hypo sludge (paper industry waste) has a tremendous potential in this context and it is well documented that the use of hypo sludge in concrete results in a significant improvement is the rheological prosperities *[Chavan and et. al. (2020)]*.

Paper trash (hypo sludge) is a byproduct of the paper and board manufacturing industry. Paper waste is projected to account for 0.7 % of total urban waste created in India. The paper industry has a serious economic and environmental dilemma in the form of paper sludge. Strong and weak fibres can be found in paper sludge. The strong waste fibres are used in the recycling process to generate recycled paper, while the weak waste fibres are disposed of. As a result of this disposal, there is a serious problem with air, water, and soil pollution. Paper sludge is being replaced with cement to reduce the disposal problem. Paper waste acts like cement due to its silica and magnesium characteristics, which enhances the setting time of cement..

Hypo sludge was first introduced as an artificial pozzolana, including a small quantity of silica, magnesium, and a significant amount of lime, which is the primary property of cement. The mechanical, physical, and chemical features of hypo sludge, which is utilised as a replacement in the production of mortar, were examined. The use of waste materials instead of raw materials will save resources and prevent environmental and ecological damage caused by quarrying and exploitation of raw materials for cement production. There is an increasing need for low-cost concrete around the world; by making this concrete, the demand for concrete will be reduced, and CO2 emissions from the cement sector will be reduced. This

project describes the technical and environmental benefits of using supplemental cementitious materials and investigates the design parameters of concrete when paper waste is used as a partial replacement for cement.

Some businesses incinerate their sludge, contributing to our major air pollution concerns. It is critical to generate lucrative construction materials from these industrial wastes in order to address disposal and environmental issues. With this in mind, experiments were conducted to generate low-cost concrete by combining various cement-to-hypo sludge ratios. Paper production generates a significant amount of solid waste. Paper fibres can only be recycled so many times before they become too short or weak to be used to manufacture high-quality paper. *[Raghu and Rao (2021)]*

II LITRATURE REVIEW:

1) **G.L. Abishek (2017)** Concrete is strength and tough material but it is porous material also which interacts with the surrounding environment. The durability of concrete depends largely on the movement of water and gas enters and moves through it. To produce low cost concrete by blending various ratios of cement with hypo sludge & to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. To make good quality paper limited number of times recycled Paper fibers can be used which produces a large amount of solid waste. The innovative use of hypo sludge in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. This research work is concerned with experimental investigation on strength of concrete and optimum %age of the partial replacement by replacing cement via 10%, 20%, 30% and 40% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength, split tensile strength and flexural strength.

2) **Devi et. al. (2018)** The rapid increase in construction activities leads to active shortage of conventional construction Materials such as cement, fine aggregate and coarse aggregate. To produce low cost concrete by blending various ratios of fine aggregate with hypo sludge and to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. These tests were carried out to evaluate the durability studies for after 28 days. This research work is concerned with experimental investigation on strength of concrete and optimum %age of the partial replacement by replacing fine aggregate via 5%, 10%, 15%, and 20% of Hypo Sludge. Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like acid attack, sulphate attack, Rapid chloride penetration, sorptivity test were conducted. The mix design was carried out for M20 grade concrete as per IS: 10262-2009.

3) **Chavan and et. al. (2020)** The increasing amount of wastes is a concerning reality that has arose the sustainability issues for the environment. Large amount of hypo sludge (from paper mill industry). Are generated around 300 million tons annually. Their disposal generally by landfills leads to environmental pollution. Also, the production of cement accounts the global warming by releasing carbon dioxide. Therefore an innovative use of the industrial wastes in concrete formulation (rigid pavement) as the supplementary cemetatious material can help in minimizing the environmental problem. This research work is concerned with the experimental investigation of the strength of concrete blended with hypo sludge. The cement has been replaced by hypo sludge in the range of 10% to 40% of weight of cement. Concrete mixtures were produced, tested and compared with the conventional concrete mix in the terms of workability, compressive strength and splitting tensile strength. The tests were carried out after 3,7 and 28 days. The gradual increase was seen in compressive strength and splitting tensile strength of concrete blended with 10% to 40% of hypo sludge content for all curing ages. Beyond that there is a significant reduction in strength. The maximum compressive strength and splitting tensile strength of M20 concrete mix were 31.6 N/mm2 and 3.5 N/mm2. Also the cost analysis indicates that with incorporation of hypo sludge decreases the cost of concrete.

4) **Aravindhraj et. al. (2020)** Concrete is strength and hard-hitting material but it is permeable solid also which interacts with the surrounding environment. The durability of concrete depends mostly on the movement of water and gas enters and moves through it. To produce low cost concrete by blending various ratios of cement with hypo sludge & to reduce disposal and pollution problems due to hypo sludge it is most essential to develop profitable building materials from hypo sludge. To make good quality paper limited number of times recycled Paper fibers can be used which produces a large amount of solid waste. The innovative use of hypo sludge in concrete formulations as a supplementary cementations material was tested as an alternative to traditional concrete. These tests were carried out to evaluate the mechanical properties like compressive strength up to 28 days. This research work is concerned with experimental investigation on strength of concrete and optimum %age of the partial replacement by replacing cement via 5%, 10%, and 15% of Hypo Sludge. The concrete grade was M25.Keeping all this view, the aim of investigation is the behavior of concrete while adding of waste with different proportions of Hypo sludge in concrete by using tests like compression strength and split strength.

5) **Raghu and Rao (2021)** The global cement industry contributes about 9% of greenhouse gas emission to the earth's atmosphere and industrial wastes are being produced by 420 million tonnes per annum by chemical process in India. In order to reduce cement manufacturing and disposal problem of paper waste, there is a need to develop alternative binders in construction field. Utilization of industrial waste products as Supplementary Cementitious Material (SCM) in concrete is very important aspect in view of economical, environmental and technical reasons. This work examines by using paper waste (hypo sludge) as partial replacement of cement & it is most essential to develop profitable building materials from hypo sludge. It is directed towards developing low cost concrete and light weight concrete from paper industry waste. The use of hypo sludge in concrete. These tests were carried out to evaluate the mechanical properties like compressive strength and spilt tensile strength and flexural strength up to 7 days, 14 days and 28 days. In this work, M25 grade concrete was developed by replacing cement via 10%,15%,20%,25% and 30% of hypo sludge. The strength on concrete made with hypo sludge are compared with normal concrete. Industrial wastes are being produced per annum by chemical and agricultural process in India. These materials possess problems of disposal and health hazards. The wastes like phosphorous gypsum, fluoro gypsum, hypo-sludge and red mud contain obnoxious impurities which adversely affect the strength and other properties of building materials based on them. To reduce disposal and pollution problems emanating from these industrial wastes. it is most essential to develop profitable building materials from them. This project is concerned with experimental investigation on strength of concrete and optimum %age of the partial replacement.

III Hypo Sludge

One of the by-products of the paper industry is hypo sludge. The utilization of these by-products has environmental benefits in that it diverts material from the trash stream, reduces energy consumed in processing virgin resources, and reduces pollution. Despite a dramatic surge in the previous three to four years, India is a resourceful country in terms of industrial waste generation, with an annual output of over 300 million tones. However, utilization remains below 20%. Consistently high-quality Hypo sludge is widely available, and people are aware of the benefits of using it in concrete.

IV Need For Hypo Sludge Utilization.

Various wastes emerge from the various processes in the paper industry during the manufacturing of paper. Our project uses hypo sludge, a preparatory waste with minimal calcium, to replace cement in concrete. Greenhouse gases are discharged into the atmosphere as a result of cement manufacture. 1 million T of greenhouse gases are released in the production of 4 million T of cement. Furthermore, in order to minimise environmental degradation, this sludge was not disposed of in large quantities on land.

V MATERIALS USED AND THEIR PROPERTIES

A. Cement

Cement is created by finely grinding calcined limestone and clay into a grey powder. Cement is one of the project's binding agents. The cement and water combine to form a paste that binds the other ingredients. The cement used is Ordinary Portland Cement (53 grade) that meets IS:8112-1989 specifications. On cement, numerous tests were carried out.

Figure 1. Cement

Table 1. Properties of Cement

Grade	OPC 53
Specific gravity	3.18
Fineness	2%
Initial setting time	32 min

B. Fine Aggregate

Clean river sand with a maximum size of 4.75mm, adhering to Zone II of IS 383-1970, was used as fine aggregate throughout the project. Sand is a granular material made up of finely fragmented rock and mineral particles that occurs naturally. The physical parameters of fine aggregate are examined in line with IS:2386, including specific gravity, fineness modulus, and water absorption.

Figure 2 Sand

Table 2. properties Of Fine Aggregate

Properties	**Values**
Specific gravity	2.74
Fineness modulus	3.2
Water Absorption	1.046%

C. Coarse Aggregate

Crushed granite or basalt rock, according to IS:383, is used to make coarse aggregate. The coarse aggregate utilized is 20mm in size. Specific gravity, fineness modulus, and water absorption properties of coarse aggregate are examined in line with IS:2386.

Figure 3. Coarse aggregates

Table 3. Properties of Coarse Aggregate

Properties	**Values**
Specific gravity	2.72
Fineness modulus	7.018
Water Absorption	0.5%
Impact Value	34.55%

D. Hypo Sludge

Hypo sludge is a waste product originating in the paper industry. Because of its silica and magnesium content, hypo sludge behaves like cement. It is an excellent concrete binding chain material. The chains also pack consistently in areas, forming a hard, stable crystalline region that adds even more stability and strength to the bundle chains. In concrete, hypo sludge is used to replace 10%, 20% and 30% of the cement. The compressive strength and spilt tensile strength were also measured after 7 and 28 days, respectively.

One of the by-products of the paper industry is hypo sludge. The utilization of these by-products has environmental benefits since it diverts the material from the trash stream, reduces the energy required to process virgin materials, and reduces pollution. Despite a dramatic growth in the previous three to four years, India is a resourceful country for the generation of industrial wastes, with an annual output of over 300 million tones. However, utilization remains below 20%. Availability of high-quality Hypo sludge across the country, as well as knowledge of the benefits of employing Hypo sludge in concrete.

Figure 4. Hypo sludge

Table 4. Properties Of Hypo Sludge

Properties	**Values**
Specific gravity	2.9
Fineness	9%
Initial setting time	35 min

E. Water

Water is an important ingredient of concrete as it actually participates in the chemical reaction with cement. Since it helps to from the strength giving cement gel, the quantity and quality of water is requiredto be looked into very carefully[6-9].

VI EXPERIMENTAL PROGRAM

A. Mix Proportion

The mix design was prepared for maximum size of aggregate 20mm. The grade of concrete prepared for the experimental study was M30. The mix proportion was 1: 1.065: 2.45 with water cement ratio 0.45. The cement content in concrete was 438 kg/m^3.

Cube specimens of size 150 x 150 x 150 mm and cylinder specimen of size 100 x 200mm were used for the research for the determination of Compressive strength and split tensile strength. Specimens were remoulded after 24 hours of casting and were kept in a curing tank for water curing .The specimens to be tested were taken from the curing tank on 7th and 28th days of curing. Fig.6 shows the casting specimen for test on hardened concrete.

Table 5. Material for 1m^3 Concrete

S.	Ingredients	Mix Design			
		CC	WP S1	WP S2	WP S3
1	Cement (kg/m^3)	440	396	352	320
2	Fine aggregate(kg/m^3)	710	710	710	710
3	Coarse aggregate (kg/m^3)	1110	1110	111	111
4	Hyposludge (kg/m^3)	0	44	88	120

B. Workability

The workability of various mixes were assessed by determining the Slump value as per the IS 1199:1959.

Table 6. Slump Value For Various Concrete Mixes

Name of Mix	Slump value
MIX 1 (Normal concrete)	55
MIX 2 (5% hypo sludge)	54
MIX 3 (10% hypo sludge)	54
MIX 4 (15% hypo sludge)	53
MIX 5 (20% hypo sludge)	53
MIX 6 (25% hypo sludge)	51
MIX 7 (30% hypo sludge)	50

C. Casting and Curing of Specimens

Figure 5. Casting specimen for test onhardened concrete.

D. Compressive Strength

The cement, fine aggregate, coarse aggregate and hypo sludge are mixed in dry state and then the desired water quantity is added and the whole concrete is mixed for 5 minutes, the concrete is poured in the mould which is screwed tightly. The concrete is poured into the mould in 3 layers by poking with tamping rod for cubes of 150x150x150mm size were tested for compression. The cast specimens are removed after 24 hours andthese are immersed in a water tank. After a curing period of 7, 14, 21 and 28 days the specimens are tested for compression strength as shown in table 7. These results are compared with conventional concrete.

Table 7. Compressive Strength of Hypo SludgeReplacement Concrete

Name of Mix	Compressive Strength (N/mm^2)			
	7 days	14 days	21 days	28 days
MIX 1 (Normal concrete)	24.58	27.42	28.03	30.47
MIX 2 (5% hypo sludge)	25.42	28.03	28.65	31.15
MIX 3 (10% hypo sludge)	26.25	28.63	29.27	31.82
MIX 4 (15% hypo sludge)	24.10	25.77	26.34	28.64
MIX 5 (20% hypo sludge)	21.95	22.91	23.42	25.46
MIX 6 (25% hypo sludge)	19.59	20.61	21.06	22.90
MIX 7 (30% hypo sludge)	17.22	18.29	18.7	20.33

E. Split Tensile Strength

The concrete is poured into the mould in 3 layers by poking with tamping rod for cylinder of 100mmdiameter x 200mm height size were tested for split tensile strength. The cast specimens are removed after 24 hours and these are immersed in a water tank. After curing period of 7th and 28th days the specimens are tested for split tensile strength and the results are obtained as in table 8. These results are compared with conventional concrete[14-17].

Table 8. Split Tensile Strength Of Hypo SludgeReplacement Concrete

Name of Mix	**Split tensile strength (N/mm^2)**	
	7 days	**28 days**
MIX 1 (Normal concrete)	4.16	5.32
MIX 2 (5% hypo sludge)	4.67	5.80
MIX 3 (10% hypo sludge)	5.17	6.28
MIX 4 (15% hypo sludge)	4.49	5.49
MIX 5 (20% hypo sludge)	3.8	4.69
MIX 6 (25% hypo sludge)	3.47	4.18
MIX 7 (30% hypo sludge)	3.14	3.67

VII RESULTS AND DISCUSS IONS

5.1 Fresh Concrete

The replacement of cement with hypo sludge the workability is very low in concrete.

II HARDENED CONCRETE

A. Compressive Strength

The test results presented in Fig.6 shows that using hypo sludge as cement increases the compressive strength of it up to 10% hypo sludge compared to the compressive strength of normal concrete. In 28th days of curing, compressive strength of conventional concrete was found to be 30.47 N/mm^2,10% replacement of hypo sludge was found to be 31.82 N/mm^2. In 28 th days, 10% replacement of hypo sludge was increased when compared to the conventional concrete compressive strength. The compressive strength decreased at 20% and 30% replacement of hypo sludge.

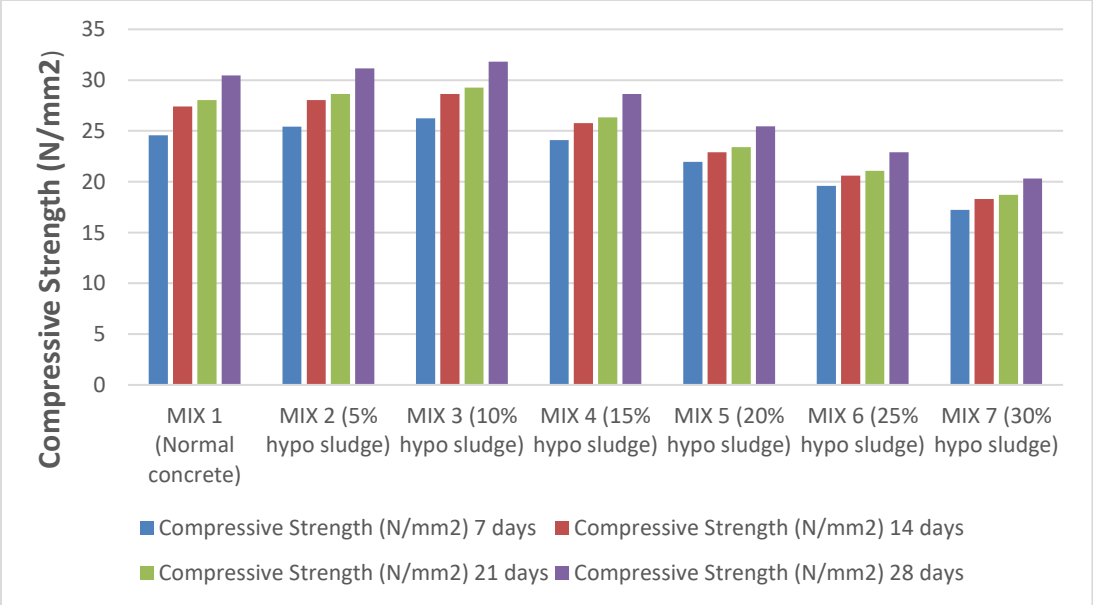

Figure 6. Compressive Strength of Hypo SludgeReplacement Concrete

B. Split Tensile Strength

The cylindrical specimen of ordinary concrete, and hypo sludge concrete were tested for split tensile strength and the results obtained are shown in fig 7. Itis seen that up to 10% replacement with hypo sludge, split tensile strength of concrete specimen increases and from MIX 3 onwards split tensile stren gth goes on decreasing. However for MIX 2 split tensile strength is greater than that of conventional concrete mix. Maximum split tensile strength is obtained for MIX 2.

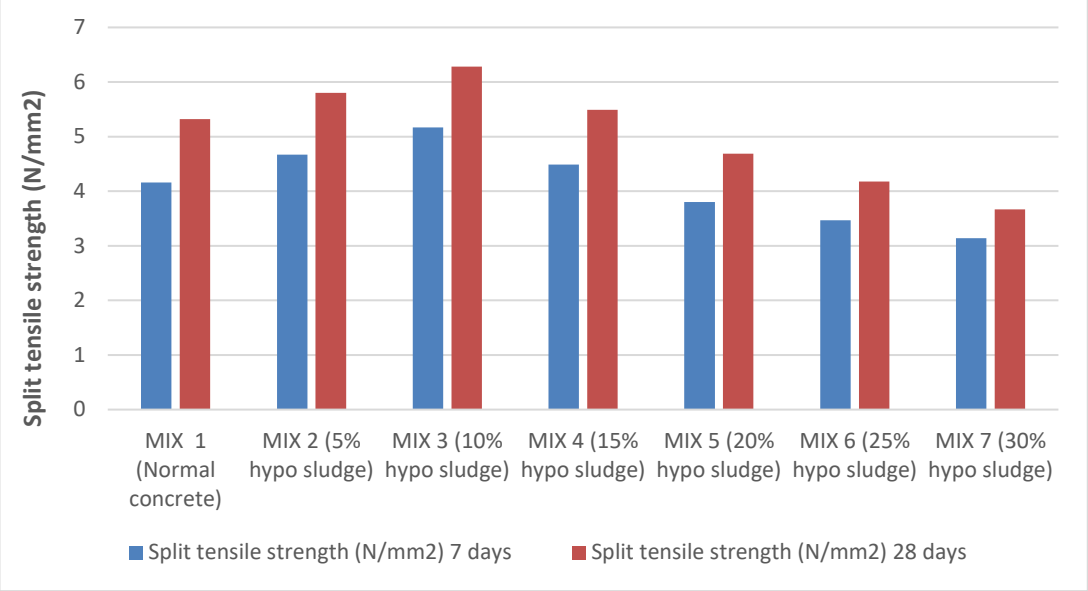

Figure 7. Split Tensile Strength of Hypo SludgeReplacement Concrete

VIII. CONCLUSIONS

The following are the conclusions

(i) Replacement of cement with hypo sludge does not have much effect ct on the workability of concrete.

(ii) Compressive strength of concrete when mixed up with 10% hypo sludge was found greater than the conventional concrete mix.

(iii) 7 days and 28 days of curing caused the high in compressive strength of 10% of hypo sludge modeling and simulation of car suspension system,incorporated concrete when compared to the conventional concrete.

(iv) Split tensile strength of concrete mixes, up to 10% Performance Replacement with hypo sludge, is greater than the conventional concrete mix.

(v) The use of hypo sludge in concrete is not only for decreasing the environmental pollution but also to decrease the cost of construction economically.

(vi) This is the best way to dispose the paper waste in an effective manner.

REFERENCE

1) Dipak Prakash Chavan,Suraj Subhash Gherade, Shubham Subhash Sanglikar3, Sumit Santosh Sable4 Prof. F.K Maniyar5 (2020) Experimental Study On Strength Of Concrete By Partially Replacing Of Cement With Hypo Sludge , Oaijse || Volume 5 || Issue 10 || October 2020 || Iso 3297:2007 Certified Issn (Online) 2456-3293 Www.Oaijse.Com

2) Aravindhraj M, Suresh Kumar A, Christyna Samuel(2020) Experimental Study On Strength Characteristics Of Concrete With Partial Replacement Of Cement By Hypo Sludge International Journal of Latest Trends in Engineering and Technology Vol.(10)Issue(3), pp.085-092 DOI: http://dx.doi.org/10.21172/1.103.16 e-ISSN:2278-621X

3) G.L. Abishek (2020) Experimental Study on Behaviour of Paper Sludge Concrete ISSN: 0976-3104 Supplement Issue www.iioab.org | Abishek 2017 | IIOABJ | Vol. 8 | Suppl 3 | 73-78 |

4) Anbu thenral devi, G. Bairavi, P. Bharath, G. Sountharya (2018) Durability Study on Hypo Sludge Concrete with Replacement of Fine Aggregate International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056 Volume: 05 Issue: 03 | Mar-2018 www.irjet.net p-ISSN: 2395-0072 © 2018, IRJET | Impact Factor value: 6.171 | ISO 9001:2008 Certified Journal | Page 2127

5) Rapuru Raghu 1, K.Mallikharjuna Rao2 "Experimental Study On Concrete With Partial Replacement Of Hypo Sludge In Cement, International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395-0056Volume: 08 Issue: 12 | Dec 2021 www.irjet.net p-ISSN: 2395-0072© 2021, IRJET | Impact Factor value: 7.529 | ISO 9001:2008 Certified Journal | Page 213

6) Brindha G., Emerging trends of telemedicine in India, Indian Journal of Science and Technology, vi-SUPPL5, pp-4572-4578, 2013.

7) Vijayalatha S., Brindha G., Emerging employee retention strategies in it industry, International Journal of Pharmacy and Technology, v 12218, 2016.

8) Karthik A., Brindha G., Green revolution conversion of offline education to online education, International Journal of Pharmacy and Technology, v 8, i-3, pp-15393-15407, 2016.

9) Padminii K., Venkatramaraju D., Brindha Study on Quality of Women Employees in Medical Transcription, Journal of Health Management, v 1, pp-13-20, 2016.

10) Gunaraja T.M., Venkatramaraju D., Brindha G., Organizational climate-pharmaceutical professional, International Journal of Pharmacy 7, i-2, pp-8924-8929, 2015.

11) Padminii K., Brindha G., Venkatramaraju D., Quality work life â€“ In medical field, International Journal of Pharmacy and Technology, v 8437-8446, 2015.

12) Gopalakrishnan K., Prem Jeya Kumar M., Sundeep Aanand J., Udayakumar R., Analysis of static and dynamic load on hydrostatic bearing with variable viscosity and pressure, Indian Journal of Science and Technology, v-6, i-SUPPL.6, pp-4783

13) Prem Jeya Kumar M., Sandeep Anand J., Gopalakrishnan K., Satheesh B., Anbazhagan R., Computer modelling of a vehicle system, Indian Journal of Science and Technology, v 4620-4628, 2013.

14) IS: 383-1970: Specification for Coarse and Fine Aggregates from Natural Sources for Concrete, Bureau of Indian Standard, New Delhi; 1970.

15) IS: 10262-1982: Recommended guidelines for concrete mix design, Bureau of Indian Standard, New Delhi; 2004.

16) IS: 8112-1989: Specification for 43 Grade Ordinary Portland cement, Bureau of Indian Standard, New Delhi; 2005.

17) IS 456-2000, Indian Standard, Plain And Reinforced Concrete - Code Of Practice