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## INDEX

Sr. No.	Title	Author	Subject	Page No.
1	Convergence of India Gaap with International GAAP / IFRS	Prof. Kalola Rimaben A.	Accountancy	1-3
2	Global Scenario of Business Ethics With Corporate Governance	Prof. Dr.Kishor V. Bhesaniya	Accountancy	4-6
3	VAT & ACCOUNTING	Miss. Mira J. Bhanderi	Accountancy	7-8
4	Carbon Trading: An Emerging Business	Dr. Basanta Khamrui, Dilip Kumar Karak	Commerce	9-11
5	Developments in Indian Non Life Insurance Industry	Ms.Kiran Sood, Ms.Supriya Tandon	Commerce	12-14
6	Parameters And Costs Influencing Transportation Decisions In Small Manufacturing Firms	Vipul Chalotra, Prof Neetu Andotra	Commerce	15-17
7	Foreign Trade Policy of India (2009-14)	Dr. M. K. MARU	Commerce	18-20
8	"A Comparative Analysis on Profitability of Selected Petroleum Industries"	Dr. Ramesh A. Dangar	Commerce	21-23
9	An Empirical study on Consumer Awareness on Internet Banking in Gujarat	Dr. Vinod K. Ramani	Commerce	24-26
10	Study of Factors Affecting HNIs' Preferences for their Banks in South Mumbai Area	Shri. Arvind A. Dhond	Commerce	27-31
11	Promotion mix strategy of jammu and kashmir co-operatives supply and marketing federation limited in jammu district of J&K state	Tarsem Lal	Commerce	32-35
12	Intelligent Brain Tumor Tissue Segmentation from Magnetic Resonance Image using forward and backward anisotropic diffusion	S.Nithya Roopa, P. Vasanthi Kumari	Computer Science	36-38
13	Share of Women in Total Family Income – A Two Group Discriminant Analysis	Dr.A.Shyamala	Economics	39-41
14	Socio-Economic Evaluation of Shg's in Bidar District of Karnataka	Dr.Sangappa V. Mamanshetty	Economics	42-44
15	The Development of Chemical and Petrochemicals Industry in Gujarat	Dr.D.G.Ganvit	Economics	45-46
16	How Can Primary Teachers Help To Assist The Development Of Positive Self-Esteem In Students Through Their Ordinary Teaching Practice?	Jigar L. Dave	Education	47-48
17	Primary Mission Of Colleges	Jigar L. Dave	Education	49
18	Effectiveness of Readers Theatre on English Reading Comprehension	Ramesh B. Sakhiya	Education	50-51
19	The Role of a Computerized Package on EFL Students' Writing Skills	Abdallah Ahmad, Baniabdelrahman, Abdulaziz A. Abanomey	Education	52-57
20	The Use of Team Teaching and its Effect on Saudi EFL Students' English Proficiency	Abdallah Ahmad, Baniabdelrahman, Abdulaziz A. Abanomey	Education	58-63
21	Study and Development of Road Traffic Noise Model	Bhavna K. Suthar V. R. Gor, A. K. Patel	Engineering	64-66

22	Weather Forecast Using Artificial Neural Network	Laxmikant Raskar, Rohit Waghchaure, Md. Danish Raza, Mayuresh Lande	Engineering	67-68
23	Pavement Subgrade Stabilisation with Rice Husk Ash	Patil N. L., Dr. Sanjay Sharma, Dr. Hemant Sood	Engineering	69-71
24	Study of Precipitation and Stream Flow Data- A Case Study of Kim Basin	Prashant A. Ramani	Engineering	72-76
25	"Estimation of Revised Capacity for Deo Reservoir of Gujarat, India"	Hiral Shah, N. N. Borad, R. K. Jain	Engineering	77-79
26	Nanotechnology in Cellular Lightweight Concrete	Mr. Nakul Shah, Prof. Jayeshkumar Pitroda	Engineering	80-82
27	Plate Load (Model) Test for Bearing Capacity of Layered Deposit	Patel Ankit D., B.R. Dalwadi	Engineering	83-85
28	Effect of Service Bridge on natural frequency of structurally coupled multistory building	Upadhyay Nishith H., Prof. A.N. Desai	Engineering	86-88
29	"Controlling the Soil & Land Pollution in Sabarkantha District by Using an Application of Remote Sensing and Geographical Information System"	Gaurang J Patel, R.B Khasiya	Engineering	89-91
30	Control The Soil Erosion & Land Pollution By Flood Reduction in The Tapi River, Surat District, Gujarat, India.	Harshad M.Rajgor, K B Khasiya	Engineering	92-95
31	Methodology for managing irrigation canal system with optimum irrigation scheduling for Meshwo irrigation Scheme	Jitendrasinh D. Raol, Roshani A.Patel, Prof S.A.Trivedi	Engineering	96-98
32	Analysis of regional water supply scheme in rural areas (Case Study: Kutch)	Niketa Patel	Engineering	99-103
33	Security For Near Field Communication in Cell Phone	Biren M Patel, Vijay B Ghadhvi, Mr Ashish Kumar	Engineering	104-106
34	Heterogeneous Traffic Flow Simulation at Urban Roundabout using 'VISSIM'	Dipti S. Thanki, Asst. Prof. Ashutosh K. Patel	Engineering	107-109
35	Planning of Facilities for Pedestrian Movement in Urban Area: A Case Study of Vadaj Circle, Ahmedabad	Hitesh A. Patel, Pinak. S. Ramanuj	Engineering	110-113
36	Planning for Non-Motorized Transportation	Jignesh C.Prajapati, Prof. N.G.Raval	Engineering	114-116
37	Intersection Design for Pedestrians and Cyclist	Jignesh C.Prajapati, Prof. N.G.Raval	Engineering	117-120
38	Theoretical Consideration for optimum irrigation scheduling for irrigation Scheme	Jitendrasinh D. Raol, Prof S.A.Trivedi	Engineering	121-124
39	Overall Equipment Effectiveness Measurement and Review of Total Productive Maintenance	Kadiya Pinjal, Navinchandra	Engineering	125-128
40	To Study the Effect Of Stiffness on the Expansion Joint of a Building Subjected to Earthquake Forces	M.D.SHAH, P. G. Patel	Engineering	129-132
41	Side Friction and Side Friction Factor (FARIC) In Ahmedabad Road Link	Parmar Dushyant J, Asst. Prof. Ashutosh K. Patel	Engineering	133-134
42	Fiber Reinforced Selfcompacting Concrete	Patel Nikunj R, Elizabeth George	Engineering	135-137

43	Modal Analysis of Helical Gear	Purusharth J. Patel, D.A. Patel	Engineering	138-140
44	Impact Strength of Ternary Blended Steel fiber Reinforced concrete	Samir M. Gami., D.A.Sinha	Engineering	141-143
45	Identify issues of traffic movement at landside area & remedial measures	Samir P. Mulani, Prof- Naurdin Hajjani	Engineering	144-147
46	Identification of Truck Transportation Issues at a Junction: a case study of Sarkhej Area	Himanshu. B. Shrimali, Prof- Naurdin Hajjani	Engineering	148-152
47	Assessment of Vehicular Carbon Footprint and its Reduction Measures	Chintan Patel, Prof. H.K.Dave	Engineering	153-155
48	Study of Solar Air Heaters with Different Operating Configurations	Ajaypalsinh Gangasinh Barad	Engineering	156-158
49	Traffic Flow Characteristics on Roads of Small Urban Centre	Axay S. Shah, Dr. L.B.Zala	Engineering	159-162
50	Failure in tensile testing on single lap multi-fastener joint with bolted connection	Jagdish N.Prajapati, Dr.Rajula.k.Gujjar, Prof.M.M.Pomal	Engineering	163-167
51	Study Of Infiltration Capacity At Anjar, Kutch	Ravi C Ahir, Sagar D Patel	Engineering	168-169
52	Comparison of Temperature-Base Methods For Calculating Reference Evapotranspiration With Standard Penman-Monteith Method	M.R.Popat, S.N.Chavda, B.H.Pandit	Engineering	170-172
53	Electronic customer relationship management: benefits and trend	Tanuja Nair	Engineering	173-174
54	VIRTUAL CLASS ROOM USING MOBILE AD-HOC NETWORK	Gaurav Katariya, Yogesh Parkhe, Devendra Patil, Pawan Pawar	Engineering	175-176
55	PARKING EVALUATION: A CASE STUDY OF AMUL DAIRY ROAD ANAND	Jaydipsinh P. Chudasama, Dr. L.B.Zala	Engineering	177-180
56	ENERGY ANALYSIS OF SOLAR AIR HEATER BY USING DIFFERENT TYPES OF ABSORBER PLATES	Vivek B. Patel, Dr. L.B.Zala	Engineering	181-183
57	Effect of Aspect Ratio W/L ,Body Bias ,and supply Voltage (vDD) for NMOS & PMOS transistor.	Rubina Siddiqui, Angeeta Hirwe, Rahul Parulkar	Engineering	184-186
58	Spider diversity of Wan Wild life Sanctuary, Vidharbha , India.	Taktode N.M.	Environment	187-188
59	The Initial Human Behavioural Response to Rapid On set Natural Disaster: Earthquake	S.S. Patil, K.L. Karkare, I.B. Ghorade	Environmental Science	189-190
60	Spatio-temporal Distribution of Surface Water for Irrigation in Satara District of Maharashtra: An Analytical Study	Pawar D. H., Jadhav K.R.	Geography	191-193
61	Nagarcha wadh v kushi bhumi upyog badal nanded-vaghan ek abhyas pahani	Prof. Mane Deshmukh R. S., Dr. S. B Rathod	Geography	194-196
62	Socio-Economic and Nutritional Status of Children with Mental Retardation	Dr. S. S. Vijayanchali	Home Science	197-199
63	Motivating Employees under Adverse Conditions	Dr Alpesh B Joshi	Human Resource	200-202
64	"Strategic Human Resource Management"	Dr. M. Venkatasubba Reddy, B. Swetha, S. Jaya Krishna	Human Resource Management	203-204

65	Identifying Crosscutting Concerns for Software Requirement Engineering	Velayutham Pavanasam, Chandrasekaran Subramaniam	Information Technology	205-207
66	Gate pass Automation with Image,Barcode reading and Biometrics	Sumant C. Murke, Tejas N. Athavale, Sangram A. Nalawade	Information Technology	208-210
67	Plight of Rape Victims With Special Reference to India	Dr. Monica Narang, Richa Sabharwal	Law	211-212
68	Libraries: An Essential Tool for the Advancement of Knowledge Resources & Research in Recent Era	Dr. Umesh Patel	Library Science	213-215
69	An Analytic Study of BA/BSc/BCA/BCom Part I General English Syllabus Prescribed by the University of Jammu	Dr. Wajahat Hussain	Literature	216-217
70	A Study on Quality of Work Life	Dr.N.Thenpandian	Management	218-219
71	Best HR Practices	Kavita Trivedi	Management	220-221
72	A Study on Employee Retention Practices of Automobile Industry in INDIA	Dr.K.Balanaga Gurunathan, Ms. V.Vijayalakshmi	Management	222-224
73	A Study on Innovation for Organizational Excellence in Health Care Industry in a Private Multi-Speciality Organization	Dr. C. Swarnalatha, T.S. Prasanna	Management	225-227
74	“Performance measurement of Top 10 Mutual Funds with the help of Sharpe, Treynor & Jensen Model”	Monal Patel, Dr. Deepak H. Tekwani	Management	228-230
75	Strategic Expansion for Growth A Case Study on Codescape Consultants Pvt Ltd. (Infinite Possibilities)	Akshay Arora, Abhilansh Bhargava, Preeti Sharma	Management	231-232
76	Role Of Education In Innovation For Economic Development - A Case Study	Dr. Ananthapadmanabha Achar	Management	233-238
77	ROLE OF HR PROFESSIONAL IN DEALING DISCIPLINARY PROCEEDINGS CONSTRUCTIVELY - AN OVERVIEW	C Santhanamani, Dr. N. Panchanatham	Management	239-241
78	Power of Advertising	Supriya Tandon	Management	242-244
79	Enhancing Employee Engagement: A Need of The Hour	Urmila Vikas Patil	Management	245-247
80	Role of E-Learning to Enhance Qualities of Physical Education Teachers and Coaches	Gohil Rajendrasinh K.	Physical Education	248-250
81	“Eco – Environmental Study on Nutrient Removal Potential of Eichhornia Crassipes from Domestic Wastewater”	D. K. Patel, V. K. Kanungo	Science	251-253
82	Aphasia – a loss of linguistic faculty	Dr Alpesh B Joshi	Social Sciences	254-256
83	Workaholism – A Modern Day Nuisance	Dr Alpesh B Joshi	Social Sciences	257-258
84	Vartman me Dalit Varg ki Samasya	Dr. H. L. Chavda	Sociology	259-260





## Nanotechnology in Cellular Lightweight Concrete

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### ABSTRACT

*The world of the construction sector is being changed by new technologies, new materials, new building typologies, new concerns and opportunities. The construction sector has been slow to embrace nanotechnology, but nanotech innovations have an enormous impact on building design and construction. Nanotechnology represents a major opportunity for the construction sector to develop new products, substantially increase quality, and open new markets. In this paper the performance of Cellular Lightweight Concrete by addition of Nano-silica has been studied through measurement of compressive Strength. The experimental results show that the durability of the concrete mixed with the nano particles were better than that of a plain concrete.*

**Keywords : Nanotechnology, Nanomaterials, New construction, Cellular Lightweight Concrete**

### I. Introduction

Nanotechnology is a recently developed, major enabling tool, already well established in several sectors of science, which is expanding rapidly into applied sciences, technology and engineering. It leads to development of advanced characterization and eventual prediction and control of properties of materials at a sub-micron level. Applications of Nanotechnology are expected to lead to better, cleaner, cheaper, faster and smarter products. In addition, much more effective use of basic resources and development of environmentally sustainable production processes are predicted.

It has been well recognized that the use of pozzolanic materials such as silica fume and fly ash is necessary for producing high performance concrete, because of significant improvements attained on the interfacial zone of cement paste-aggregate. In recent years, there has been a growing interest in the use of Nano silica (NS) as a mineral admixture for similar purposes. Nano silica particles can react with calcium hydroxide crystals, which are arrayed in the interfacial transition zone (ITZ) between cement paste and aggregates, and produce C-S-H gel. A stable gel structure can be formed and the mechanical properties of cement paste can be improved when a smaller amount of Nano silica is added.

However, up to now, there are few published reports on the durability of Nano silica concrete. The research shows that Nano silica can improve the micro structure of the ITZ and durability of concrete.

Nanotechnology (sometimes shortened to "nanotech") is the study of manipulating matter on an atomic and molecular scale. Generally, nanotechnology deals with developing materials, devices, or other structures possessing at least one dimension sized from 1 to 100 nanometres. Quantum mechanical effects are important at this quantum-realm scale.

Cellular concrete is generally defined as a lightweight cementitious material that contains stable air or gas cells uniformly distributed throughout the mixture at a volume greater than twenty percent. In lay terms, it can be thought of as a concrete, which utilizes a stable air cell structure rather than traditional aggregate. Cellular concrete is engineered, low-density

concrete with special properties germane to solving a sweeping assortment of construction, mining, and manufacturing challenges.

In instances where projects are sited on marginal lands with areas of soft or loose soils incapable of supporting typical aggregate loads, the use of pervious cellular lightweight concrete (PCLWC) technology permits designers and geotechnical engineers to control both site bearing capacity and drainage characteristics.



Fig: Cellular Lightweight Concrete

### II. Experimental

#### A. Materials

**Cement: The cement used is Binani Cement and physical test result shown in Table 1. (IS: 12269-1987)**

Table 1: Physical Test of Cement

Sr No.	Test	Result	I.S. Requirements
1	Consistency	28.50%	-
2	Setting time	-	-
a	Initial Setting time	85 minutes	Shall not be less than 30 minutes
b	Final setting time	190 minutes	Shall not be less than 600 minutes
3	Soundness test	2.40	Expansion shall be less than 10mm
4	Compressive test	-	-

a	3-days strength	30.46 N/mm <sup>2</sup>	Shall not be less than 27 N/mm <sup>2</sup>
b	7-days strength	39.13 N/mm <sup>2</sup>	Shall not be less than 37 N/mm <sup>2</sup>
c	28-days strength	55.68 N/mm <sup>2</sup>	Shall not be less than 53 N/mm <sup>2</sup>
5	Fineness (blain's)	2380 cm <sup>2</sup> /gm	Specific surface shall be >2250 cm <sup>2</sup> /gm

Sand: The Sand used is washed river sand 1.18mm particle size from sevaliya and bodeli. (IS: 2116-1965, IS: 383-1963).

Water: The water used in the manufacture of concrete is from BVM college, free from matter harmful to concrete (IS:3025).

**Table 2: Test result of Water**

Sr No.	Tests	Test Result	Limit as per IS 456-2000
1	pH value	6.68	Min. 6.0
2	Chloride (as Cl) (mg/l)	39.19	Max. 2000 mg/l for P.C.C. Work and Max. 500 mg/l for Concrete with steel and R.C.C. Work
3	Sulphate SO <sub>3</sub> mg/l	62.14	Max. 400 mg/l
4	Inorganic Matter mg/l	98.60	Max. 3000 mg/l
5	Suspended Solids mg/l	0.42	Max. 2000 mg/l
6	Organic Matter mg/l	19.50	Max.200 mg/l
7	Neutralization with 0.02N HCL, ml	2.60	It should not more than 25 ml in 100 ml sample
8	Neutralization with 0.02N NaOH, ml	1.50	It should not more than 5 ml in 100 ml sample
9	Turbidity, NTU	0.17	-
10	Colour, Hazen unit	Colourless	-
11	Odour	Unobjectionable	-
12	Total hardness(CaCO <sub>3</sub> ), mg/l	10.00	-
13	Dissolved solids, mg/l	114.00	-
14	Calcium (as Ca), mg/l	1.20	-
15	Magnesium (as Mg), mg/l	1.70	-
16	Total Alkalinity (as CaCO <sub>3</sub> ),mg/l	26.0	-

Preformed Foam: The foam used is REMIFOAM MYK Schomburg. Preformed foam is created by diluting a liquid foam concentrate with water in predetermined proportions and passing this mixture through a foam generator. Technical data sheet is given Table.

**Table 3: Technical Data Sheet**

Raw material base	Surfactant
Colour	Clear
Form	Liquid
Processing Temp.	Beyond +5°C
Density	1.00g/cm <sup>3</sup>
Storage	Protect from frost and dirt
Shelf life	12month at 20°C in closed original containers

**DOSAGE:**

- Use with foam generator, Mix MYK REMIFOAM with water in the ration 1:40. 1kg MYK REMIFOAM yields approx 550-600 litres of foam dosage quantities of the construction material.
- Used as an admixture.

Nano-Silica: The Nano Silica used is taken from Material and Science department, Sardar patel University, V.V.Nagar. Nano Silica (NS) can contribute to efficient 'Particle Packing' in concretes by densifying the micro and nanostructure leading to improved mechanical and durability properties. Nano Silica can control degradation (through blocking of water entry on account of pore refinement) of the fundamental binder system of hydrated cement i.e., C-S-H(calcium-silicate-hy-

drate) gel caused usually due to calcium leaching out when immersed in water.

**Mix proportion:**

Nano-Silica	-	0.810 kg
Cement	16.2 kg	16.2 kg
Sand	44.55 kg	44.55 kg
Water	6.48 litre	6.48 litre
Foam agent	25 ml	25 ml
Water in Foam	1 litre	1 litre
Quantity of Foam	12 litre	12 litre

Note: Nano Silica added 5% of Cement

**B. Specimen Fabrication:**

First, the sand, which was saturated surface dry, was placed in the mixer. The cement and Nano Silica (premixed) were added and mixing resumed for 1 min, then gently adding the 75% of mixing water and mixed for 2.5 min, the 25% mixing water. Then Foam (preformed) was added in to mixer and mixed for 4 to 5min. Finally, the fresh concrete is poured into oiled molds. The specimens are demolded at 24h and then air-cured in a standard at temperature of 20±3 C.

**C. Testing Method:**

Sr No.	Tested After (Days)	Load for Complete Crushing (Tonnes)	Stress for Complete Crushing (N/mm <sup>2</sup> )	Average Stress for Crushing (N/mm <sup>2</sup> )
1	3	16.5	7.2	6.8 N/mm <sup>2</sup>
2	3	14.3	6.2	
3	3	15.8	6.9	
4	7	20	8.7	8.7 N/mm <sup>2</sup>
5	7	19.8	8.6	
6	7	20.3	8.9	
7	28	26.5	11.6	11.7 N/mm <sup>2</sup>
8	28	27.2	11.9	
9	28	26.4	11.5	

The compressive strength test was performed in accordance with IS:6441, IS:516 cubic tests of 150 millimeters for compressive strength.

**III. Test Result and Discussions**

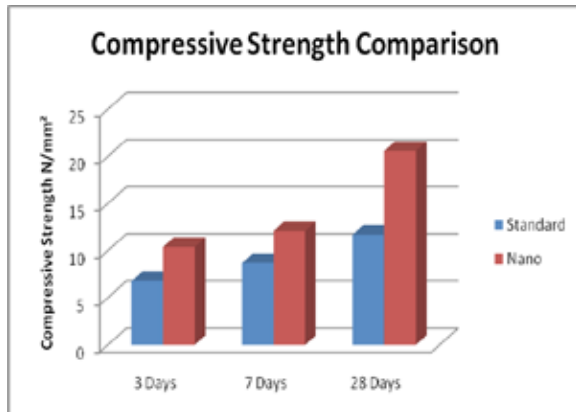
**Table 4: Test Result Cellular Lightweight Concrete - Standard**

**Table 4: Test Result Cellular Lightweight Concrete - Nano**

Sr No.	Tested After (Days)	Load for Complete Crushing (Tonnes)	Stress for Complete Crushing (N/mm <sup>2</sup> )	Average Stress for Crushing (N/mm <sup>2</sup> )
1	3	22.7	9.9	10.4 N/mm <sup>2</sup>
2	3	24.5	10.7	
3	3	24.3	10.6	
4	7	28.4	12.4	12.1 N/mm <sup>2</sup>
5	7	27.8	12.1	
6	7	27.1	11.8	
7	28	48.2	21.0	20.6 N/mm <sup>2</sup>
8	28	47.0	20.5	
9	28	46.6	20.3	

The Graph show the compressive strength of all specimens at 3rd, 7th and 28th days. It can be seen that, when Nano particles in a small amounts are added, the compressive strength of concrete can be enhanced. This result is a result of increasing the bound strength of cement paste-aggregate interface by means of the filling effect of Nano silica particles.





#### IV. Conclusion

The development of novel materials and the improvement of existing materials in response to scarcity of natural materials become a possibility through application of nanotechnology

techniques in traditional materials.

Compressive strength of the Cellular concrete can be increases with adding the Nano-Silica, especially at early ages. Research shows that the early strength of the concrete decreases slightly with adding the silica fume, but increases at later ages. These results indicate that the pozzolanic activity of Nano-silica is greater than that of silica fume.

Nano-silica consumes calcium hydroxide crystals, reduces the size of the crystals at the interface zone and transmute the calcium hydroxide feeble crystals to the C-S-H crystals, and improves the interface zone and cement paste structures.

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