iJRASET
International Journal For Research in
Applied Science and Engineering Technology

# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

**Volume:** 8 **Issue:** VI **Month of publication:** June 2020

**DOI:** http://doi.org/10.22214/ijraset.2020.6123

# Study of Properties of Self-Compacting Concrete with Cement replaced with Aluminum Oxide and Silica Fume

Mohini Khopade[1], Dr. S.V. Desale[2]
[1]*K.B.C. North Maharashtra University*

***Abstract: Now a days as the urbanization is growing rapidly, there is a need for modern materials for the economic as well as the better quality of construction. As self-compacting concrete itself has various excellent properties such as it is highly flowable, good segregation resistance, low-yield stress, high deformability, and has moderate viscosity. In the below paper, a study of the mechanical and rheological properties of self-compacting concrete (SCC) containing Aluminum oxide and silica fume has been explored. Considering the fresh properties of concrete slump flow test, V-funnel test and L-Box test have been performed. The hard-concrete properties have been conducted by using compressive strength test and splitting tensile strength test. The water absorption of the samples is tested with the water absorption test. Fifteen different amounts of Aluminum oxide (0, 0.25, 0.50, 0.75, 1, 1.25, 1.50, 1.75, 2, 2.25, 2.50, 2.75, 3, 3.25, and 3.50%) as a replacement for the cement were used. The amount of silica fume in all the samples is kept constant. According to the tests, the compressive strength of the specimen containing 2.5% Aluminum oxide as a partial cement replacement after 7, 28, and 90 days is increased by 47, 86 and 84% respectively. The splitting tensile strength of specimens containing 2.5% Aluminum oxide and 10% Silica fume as partial replacement of the cement after 7, 28, and 90 days is increased by 27, 53, and 44% respectively. This is due to the reaction between Aluminum oxide and the cement. The use of 1.75% of Aluminum oxide has reduced the water absorption by 12% and 48% respectively. By using the aluminum oxide and silica fume as a replacement in the concrete mixture in the particular amount, it results in efficient results.***

**Keywords*****: Self compacting concrete, Aluminium oxide, Silica fume, compressive test, splitting tensile strength, low water absorption, Low-segregation, fresh properties of concrete.***

## I. INTRODUCTION

This document is a template. For questions on paper guidelines, please contact us via e-mail. In many projects where the quantity of reinforcement is high and the dimensions of the concrete sections are small, self-compacting concrete can be used as an effective method for the construction.

Self- compacting concrete has a low yield stress, high distortion capacity, good resistance against segregation and tolerable viscosity. When the SCC is poured, it is an extremely fluid mix hence it flows very easily within and around the formwork and it can flow through hurdles and around corners. It mostly levels itself and does not require vibration after pouring and it follows the shape and surface texture of a mold very closely once it is set.

Subsequently, pouring SCC is much less labor-demanding compared to standard concrete mixes. Once the SCC is poured, it is usually similar to standard concrete in specification of its setting and curing time and strength. SCC uses a low proportion of water to become fluid.

It uses less water as compared to the ordinary concrete. Instead, SCC gains its fluid properties from an unusually high proportion of fine aggregate i.e. sand (typically 50%), combined with superplasticizers and viscosity-enhancing admixtures .

Mostly, concrete is heavy and slimy material when mixed. When this concrete is used in construction, it requires the use of vibration to remove air bubbles, and honeycomb-like holes, especially at the surfaces, where air has been cornered during pouring. This kind of air content is not coveted in the concrete. As it weakens the concrete if it is present in it. However, it is arduous and takes time to be removed by vibration, and incompetent vibration can lead to uncharted problems later. Also, some complex forms cannot easily be vibrated.

Hence, SCC is produced to fix this problem as it lacks the need for compaction, therefore downsizing the labor, time, and is a possible source of technical and quality control issues.

## II. LITERATURE REVIEW

As the modernization of the industry is speeding up, the materials that are to be used should also be advanced. Addition of additives make the cement mix more sustainable to the current situation in the market as there is a need for more advanced materials. In this research work, aluminium oxide and silica fume are used in the concrete. As we all know due to the increasing rate of urbanization the use of alumina or aluminium has increased. Alumina is produced from bauxite, an ore that is mined from topsoil in various tropical and sub-tropical regions. In India, the primary aluminium production was 3.39 million tonnes in 2017-2018 while the consumption was 2.08 million tonnes. Alumina conveys quick setting property to the cement but when alumina is added with cement it behaves as a flux and reduces the clinkering temperature which results in weakening the cement. Hence, to maintain the high temperature, alumina should be used in limited quantity.

Silica fume or microsilica, is an amorphous polymorph of silicon dioxide, silica. It is an ultrafine powder collected as a by-product of the silicon and ferrosilicon alloy production and consists of spherical particles. Pozzolanic reaction occurs between silica fume and the CH, producing additional CSH in many of the voids around hydrated cement particles because of the high surface area of silica fume particles affecting the manoeuvrability of water within concrete, segregation and bleeding of concrete is eradicated.

## III.METHODOLOGY

### *A. Materials Required.*

The materials used are gravel, sand, water, cement, $AL_2O_3$ and silica fume and superplasticizer. River sand with a density of 2600kg/m$^3$ and 3.2% water absorption is used. Gravel is a crushed stone type with maximum nominal size of 19mm and water absorption of 1.01% and density of 2670 kg/m$^3$. The cement used is ACC concrete cement of 53 grade. The value of initial setting time and final setting time is 34 min and 365 min, respectively. The water used for the mixing of the concrete is potable drinking water.

The $AL_2O_3$ used in this experiment is in powder form. The average size of $AL_2O_3$ particles is 20 mm. The colour of the powder is white. The particles have a specific surface of 138 m$^2$/gm and a density of 3890 kg/m$^3$

| Components (%) | Cement grade 53 | Silica Fume |
|---|---|---|
| $SiO_2$ | 21.27 | 94.6 |
| $AL_2O_3$ | 4.95 | 1.32 |
| $Fe_2O_3$ | 4.03 | 0.87 |
| CaO | 62.95 | 0.49 |
| MgO | 1.55 | 0.97 |
| $SO_3$ | 2.26 | 0.1 |
| $K_2O$ | 0.65 | 0.01 |
| $Na_2O_3$ | 0.49 | 0.31 |

Table 1 Chemical properties of cement grade 53

| Component | Amount |
|---|---|
| $AL_2O_3$ | ≥99% |
| Ca | ≤25 ppm |
| Fe | ≤80 ppm |
| Cr | ≤4 ppm |
| Na | ≤70 ppm |
| Mn | ≤3 ppm |
| Co | ≤2 ppm |

Table 2 Chemical component of $Al_2O_3$

The silica fume used in the work is used which is locally available in the market. The chemical properties of 53 grade cement and silica fume is given in table 1. The detail chemical composition of $AL_2O_3$ is given in the Table 2. The superplasticizer used in the work is POLYTANCRETE SF manufactured in Sunanda chemicals, Mumbai which is mixed in the pre-wetted concrete mix, at a rate of 0.4 to 0.8 % by wt. of cementitious material. The materials required for the work used is as shown in figure 1

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 8 Issue VI June 2020- Available at www.ijraset.com

Figure 1- Materials used.

*B. Mixed Design Of Concrete*

In this research work, to reduce the amount of cement that is used and to keep the adhesive volume of the cement constant, silica fume is used as a partial cement replacement. Previous studies introduced about 10% of silica fume as an optimum percentage of cement replacement. Hence, 10% of silica fume was replaced with cement in all the mix design. The mix design's constituents with their magnitude is given in table 3

| Mix | C | W | SF | S | G | $AL_2O_3$ | SP |
|---|---|---|---|---|---|---|---|
| NA 0 | 350 | 168 | 35 | 960 | 920 | 0 | 2.76 |
| NA 0.25 | 314.125 | 168 | 35 | 960 | 920 | 0.875 | 2.86 |
| NA 0.5 | 313.25 | 168 | 35 | 960 | 920 | 1.75 | 2.93 |
| NA 0.75 | 312.375 | 168 | 35 | 960 | 920 | 2.625 | 3.03 |
| NA 1.00 | 311.5 | 168 | 35 | 960 | 920 | 3.5 | 3.35 |
| NA 1.25 | 310.625 | 168 | 35 | 960 | 920 | 4.375 | 3.46 |
| NA 1.5 | 309.75 | 168 | 35 | 960 | 920 | 5.25 | 3.89 |
| NA 1.75 | 308.875 | 168 | 35 | 960 | 920 | 6.125 | 4.03 |
| NA 2.00 | 308.0 | 168 | 35 | 960 | 920 | 7 | 4.12 |
| NA 2.25 | 307.125 | 168 | 35 | 960 | 920 | 7.875 | 4.45 |
| NA 2.50 | 306.25 | 168 | 35 | 960 | 920 | 8.75 | 4.89 |
| NA 2.75 | 375.305 | 168 | 35 | 960 | 920 | 9.625 | 4.92 |
| NA 3.00 | 304.5 | 168 | 35 | 960 | 920 | 10.5 | 4.65 |
| NA 3.25 | 304.40 | 168 | 35 | 960 | 920 | 9.765 | 4.64 |
| NA 3.5 | 304.10 | 168 | 35 | 960 | 920 | 9.102 | 4.60 |

Table 3 -Mix properties of specimens(kg/$m^3$)

The concrete was prepared in the concrete mixer. Initial, gravel and sand were mixed in the concrete mixer, after the mix becomes homogenous half of the amount of water was mixed as per the mix design which was used, and the mixing was continued. After proper mixing of the mix, cement, silica fume and 10% of the mixing water was added to the mixture and the mixing was being continued in the concrete mixer. Finally, $AL_2O_3$ and the remaining water was added. For obtaining the SCC, the superplasticizer 8was added gradually. Adding the additives during the mixing may not be suitable for the desired chemical effects may sometime require to delay.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 8 Issue VI June 2020- Available at www.ijraset.com*

### *C. Fresh Concrete Tests*

(a) (b) (c)

Figure 2-Fresh concrete tests.

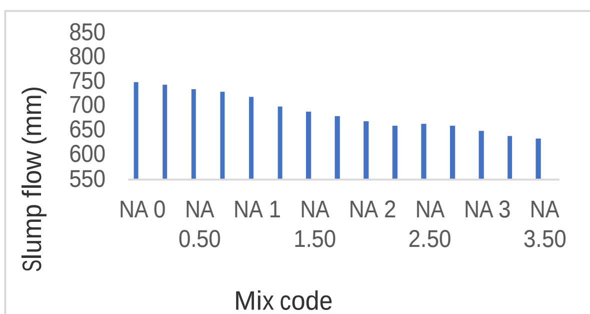
**a**. slump flow **b**. L-box **c**. V-funnel

Fresh concrete tests were carried out for this experiment were slump flow, T-50, V-funnel and L-box as shown in the above figure 2 The flowability of the SCC is determined by the slump flow test, viscosity is determined with T50 and V- funnel. However, the passing ability was resolved through the L-Box test. In the slump test, SCC is measured after flowing of concrete on the slump plate which shows the fluidity of the concrete. With L-box test, the height of the fresh SCC is measured after passing through the specific intervals between the steel bars, and the flow is measured in one way, and its passing power and blockage are estimated. The V-funnel is measured for determining the filling ability and concrete viscosity.

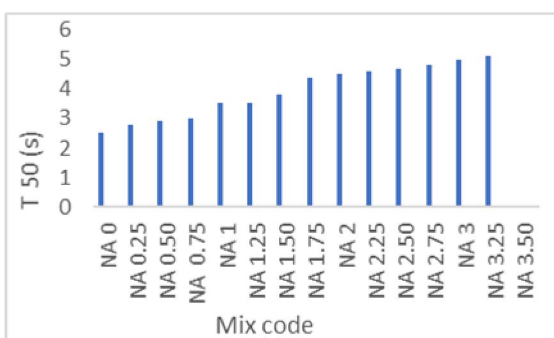
### *D. Hardened Concrete Test*

Compressive strength, tensile strength and water absorption percentage test were conducted to investigate the mechanical and physical behaviour of concrete specimens. Compressive strength and tensile strength tests were carried out at 7,28 and 90 days. Water absorption test specimens were tested after 28 days of curing condition.

## IV.RESULTS

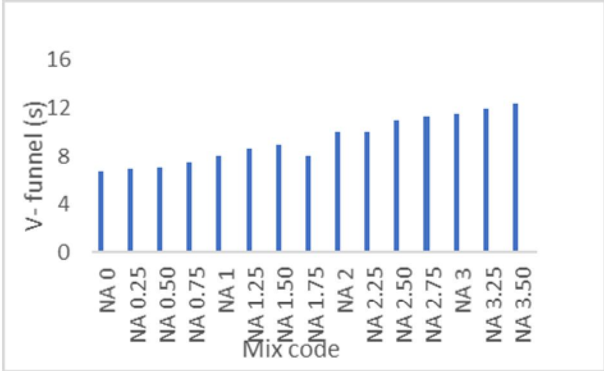



(a)

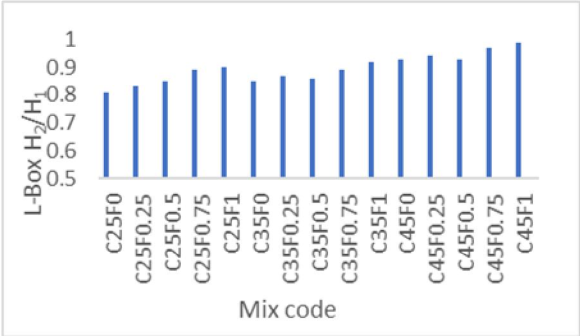



(b)

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
*ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429*
*Volume 8 Issue VI June 2020- Available at www.ijraset.com*




(c)




(d)

Fig. 3 Fresh concrete test results **a** slump flow, **b** T50, **c** V-funnel, **d** L-box

### *A. Fresh Concrete Tests*

Fresh concrete test results are presented in figure 3. The Slump flow test is evaluated with the observation of concrete spreading diameter, which shows the yield stress of fresh concrete. According to the Indian standards, if the average value of the 2 dimension is less then550 mm, then the yield stress of the fresh concrete is high and its workability is low and if the average value of the 2 diameter is greater than 850 mm, the yielding stress is low and there is a possibility of segregation. The slump flow of all the mixes ranged from 663 to 749 mm, which is very suitable for regular concrete work. It is observed that the all the mixes had very good flowability due to good aggregate gradation, proper mixing and suitable amount of plasticizer. The mixes which contained $AL_2O_3$ and silica fume were observed then their slump was less than the controlled specimen this is due to the softness of $AL_2O_3$ and silica fume. Aluminium dioxide and silica fume enhanced the properties of the concrete like filling, bonding and evenness of the concrete, and it also reduced its diffusion diameter of concrete in slump flow.

Good workability is obtained with the use of super plasticizer.

The self-compacting concrete should be checked in terms of viscosity. The viscosity is tested with the use of V-funnel passing time and T50 test. the concrete passing through the V-funnel showed homogeneity of concrete in all cases,

The L-box test evaluated the blockage due to the presence of the bars and indicated the passing ability of SCC through the tight intervals through the bars. The stoppage ratio in all the mixtures was in the range of 0.8-1. The mixtures with this range will have a good passing ability. All the fresh concrete test was carried out in an appropriate time interval from the addition of super-plasticizer and the super-plasticizer did not lose its effect.

### *B. Hardened Concrete Tests*

In the experiment, the compressive and tensile strength were conducted at the age of 7,28, and 90 days in the presence of various percentages of $AL_2O_3$. The result is given in the table 4. Compressive strength of the concrete was increased by increasing the amount of $AL_2O_3$ and increasing the age of concrete. According to the table 4, the compressive strength of the specimen containing 2.5% $AL_2O_3$ after 7,28, and 90 days is increased by 48,88, and 86% respectively. The reason for this increase in the strength is due to the reactivity of $AL_2O_3$ with Portland cement during the hydration process of cement. As $AL_2O_3$ is in fine powder form, it fills the cavities in the cement gel and improves the compressive strength. The percentage increase in compressive strength

The percentage increase in the splitting tensile strength in comparison with the control specimens is presented in Table 4.
The water absorption of the specimens after 28 days for 13 concrete mixtures is presented in Figure 6. As it is observed, the more the use of $AL_2O_3$ in all mixtures the less is the water absorption process.

| Mix | Compresive strength (Mpa) | | | Spliting tensile strength(Mpa) | | |
|---|---|---|---|---|---|---|
| | Days | | | Days | | |
| | 7 | 28 | 90 | 7 | 28 | 90 |
| NA 0 | 20.7 | 25.66 | 28.89 | 2.74 | 2.84 | 3.63 |
| NA 0.25 | 21.88 | 26.84 | 30.07 | 2.81 | 2.91 | 3.7 |
| NA0.50 | 23.76 | 28.72 | 31.95 | 2.84 | 2.94 | 3.73 |
| NA 0.75 | 24.61 | 29.57 | 32.8 | 2.85 | 2.95 | 3.74 |
| NA 1 | 25.62 | 30.58 | 33.81 | 2.86 | 2.96 | 3.75 |
| NA 1.25 | 25.79 | 30.75 | 33.98 | 2.87 | 2.97 | 3.76 |
| NA 1.50 | 26.68 | 31.64 | 34.87 | 2.93 | 3.03 | 3.82 |
| NA 1.75 | 27.57 | 32.53 | 35.76 | 3.14 | 3.24 | 4.03 |
| NA 2 | 28.64 | 33.6 | 36.83 | 3.34 | 3.44 | 4.23 |
| NA 2.25 | 29.31 | 34.27 | 37.5 | 3.36 | 3.46 | 4.25 |
| NA 2.50 | 30.29 | 35.25 | 38.48 | 3.54 | 3.64 | 4.43 |
| NA 2.75 | 29.52 | 34.48 | 37.71 | 3.44 | 3.54 | 4.33 |
| NA 3 | 29.41 | 34.37 | 37.6 | 3.35 | 3.45 | 4.24 |
| NA 3.25 | 29.13 | 34.09 | 37.32 | 3.25 | 3.35 | 4.14 |
| NA 3.50 | 28.99 | 33.95 | 37.18 | 3.15 | 3.25 | 4.04 |

Table 4- Hardened Concrete Test Results- (compressive strength and tensile strength)

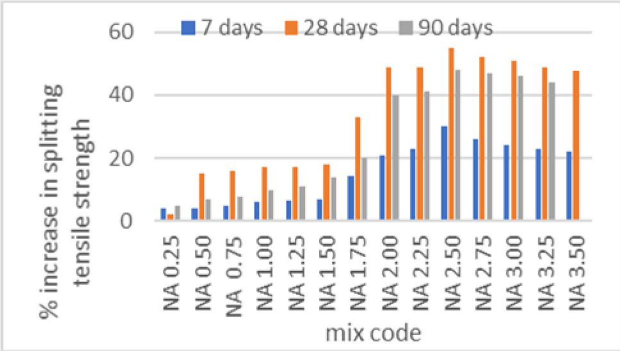



Figure 4- Percentage increase in splitting tensile strength

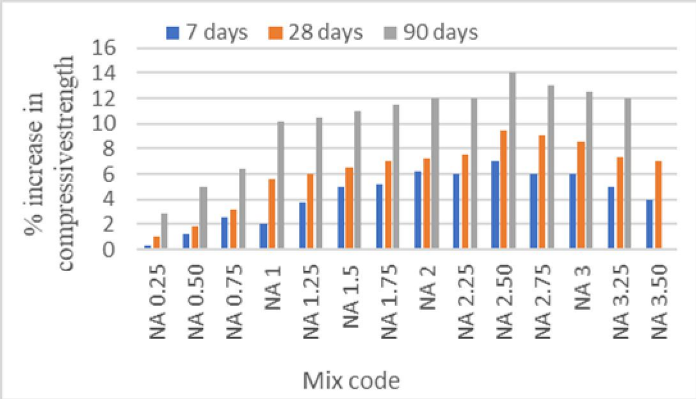



Figure 5- percentage increase in compressive strength

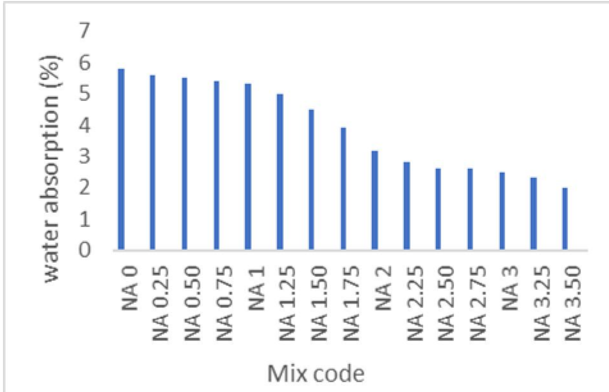



Figure 6- Percentage indicating the water absorption

## V. CONCLUSION

In the above research, the behaviour of mechanical and rheological properties of Self-compacting concrete containing $AL_2O_3$ and silica fume are studied. Compressive strength, tensile strength and water absorption percentage test were conducted to investigate the mechanical and physical behaviour of concrete specimens. According to the results obtained from the experiments, the following conclusion can be presented as:

*A.* Increasing the $AL_2O_3$ reduced the fluidity, increases the yield stress, and reduces the filling ability of Self compacting concrete. The properties of the fresh SCC are achieved by using super-plasticizer. Good workability is achieved by the addition of super-plasticizer.

*B.* The increase in $AL_2O_3$ powder increases the homogeneity and consistency of concrete. Due to the higher effective surface and more water absorption, $AL_2O_3$ reduces the efficiency and increases the strength against fluidity and viscosity.

*C.* Compressive strength is increased by the increasing amount of $AL_2O_3$ and increasing age of concrete, it is maximum when $AL_2O_3$ amount is 2.5% and after that the reduction in the compressive strength is observed.

*D.* The surface area gets cracked of the specimens without no $AL_2O_3$ in comparison with the specimens containing $AL_2O_3$, this is due to the powder form of $AL_2O_3$ which affects the concrete matrix and reduces its cracking.

## REFERENCE

[1] Agarkar SV, Joshi MM (2012) Study of effect of Al2O3 nanoparticles on the compressive strength and workability of blended concrete. Int J Curr Res 4:382–384
[2] Al Ghabban A, Al Zubaidi AB, Jafar M, Fakhri Z (2018) Effect of nano SiO2 and nano CaCO3 on the mechanical properties, durability and flowability of concrete. In: IOP conference series: materials science and engineering, vol 454, no 1, IOP Publishing, p 012016
[3] Arefi M, Javeri M, Mollaahmadi E (2011) To study the effect of adding Al2O3 nanoparticles on the mechanical properties and microstruc- ture of cement mortar. Life Sci J 8(4):613–617
[4] Ghasemi M, Ghasemi MR, Mousavi SR (2019) Studying the fracture parameters and size effect of steel fiber-reinforced self-compact- ing concrete. Constr Build Mater. https://doi.org/10.1016/j.conbu ildmat.2018.12.172
[5] Ghrici M, Kenai S, Said-Mansour M, Kadri EH (2006) Some engi- neering properties of concrete containing natural pozzolana and silica fume. J Asian Archit Build Eng 5(2):349–354. https://doi. org/10.3130/jaabe.5.349
[6] Grzeszczyk S, Jurowski K, Bosowska K, Grzymek M (2019) The role of nanoparticles in decreased washout of underwater concrete. Constr Build Mater 203:670–678. https://doi.org/10.1016/j.conbu ildmat.2019.01.118
[7] Hanumesh BM, Varun BK, Harish BA (2015) The mechanical proper- ties of concrete incorporating silica fume as partial replacement of cement. Int J Emerg Technol Adv Eng 5(9):270
[8] Hase BA, Rathi VR (2015) Properties of high strength concrete incor- porating colloidal nano-Al2O3. Int J Innov Res Sci Eng Technolgy 4(3):959–963. https://doi.org/10.15680/IJIRSET.2015.0403024
[9] Ismael R, Silva JV, Carmo RNF, Soldado E, Lourenco C, Costa H, Júlio E (2016) Influence of nano-SiO2 and nano-Al2O3 additions on steel-to-concrete bonding. Constr Build Mater 125:1080–1092. https://doi.org/10.1016/j.conbuildmat.2016.08.152
[10] Jaishankar P, Karthikeyan C (2017) Characteristics of cement con- crete with nano alumina particles. In: IOP conference series; earth and environmental science, vol 80, no 1, p 012005. https://doi. org/10.1088/1755-1315/80/1/012005
[11] Jayaseelan R, Pandalu G, Selvam S (2019) Investigation on the per- formance characteristics of concrete incorporating nanoparticles. Jordan J Civ Eng 13(2):351–360
[12] Kamal MM, Safan MA, Bashandy AA, Khalil AM (2018) Experi- mental investigation on the behavior of normal strength and high strength self-curing self-compacting concrete. J Build Eng 16:79– 93. https://doi.org/10.1016/j.jobe.2017.12.012

[13] Kaplan G, Demircan RK, Cakmak C, Gultekin AB (2019) Microwave curing effect on internal sulfate damage in nano alumina rein- forced white cement. In: IOP conference series: materials science and engineering, vol 471, no 3, IOP Publishing, p 032038
[14] Kawashima S, Hou P, Corr DJ, Shah SP (2013) Modification of cement-based materials with nanoparticles. Cement Concr Com- pos 36:8–15. https://doi.org/10.1016/j.cemconcomp.2012.06.012
[15] Langaroudi MAM, Mohammadi Y (2018) Effect of nano-clay on work- ability, mechanical, and durability properties of self-consolidat- ing concrete containing mineral admixtures. Constr Build Mater 191:619–634. https://doi.org/10.1016/j.conbuildmat.2018.10.044
[16] Li Z, Wang H, He S, Lu Y, Wang M (2006) Investigations on the preparation and mechanical properties of the nano-alumina rein- forced cement composite. Mater Lett 60(3):356–359. https://doi. org/10.1016/j.matlet.2005.08.061
[17] Nili M, Ehsani A (2015) Investigating the effect of the cement paste and transition zone on strength development of concrete contain- ing nanosilica and silica fume. Mater Des 75:174–183. https://doi. org/10.1016/j.matdes.2015.03.024
[18] Self-Compacting Concrete European Project Group (2005) The Euro-pean guidelines for self-compacting concrete: specification, pro- duction and use. In: International Bureau for Precast Concrete (BIBM)
[19] Staub de Melo JV, Triches G (2018) Study of the influence of nano- TiO2 on the properties of Portland cement concrete for application on road surfaces. Road Mater Pavement Des 19(5):1011–1026. https://doi.org/10.1080/14680629.2017.1285811
[20] Tichko S, De Schutter G, Troch P, Vierendeels J, Verhoeven R, Lesage K, Cauberg N (2015) Influence of the viscosity of self-compacting concrete and the presence of rebars on the formwork pressure while filling bottom-up. Eng Struct 101:698–714
[21] Vandhiyan R, Pillai EB (2018) influence of nano silica addition on the behavior of concrete and its impact on corrosion resistance. J Comput Theor Nanosci 15(2):530–536. https://doi.org/10.1166/ jctn.2018.7116
[22] Vera-Agullo J, Chozas-Ligero V, Portillo-Rico D, García-Casas MJ, Gutiérrez-Martínez A, Mieres-Royo JM, Grávalos-Moreno J (2009) Mortar and concrete reinforced with nanomaterials. In: Nanotechnology in construction, vol 3, Springer, Berlin, pp 383–388
[23] Zhang S, Qiao WG, Chen PC, Xi K (2019) Rheological and mechanical properties of microfine-cement-based grouts mixed with microfine fly ash, colloidal nanosilica and superplasticizer. Constr Build Mater 212:10–18

## V. CONCLUSIONS

The version of this template is V2. Most of the formatting instructions in this document have been compiled by Causal Productions from the IEEE LaTeX style files. Causal Productions offers both A4 templates and US Letter templates for LaTeX and Microsoft Word. The LaTeX templates depend on the official IEEEtran.cls and IEEEtran.bst files, whereas the Microsoft Word templates are self-contained. Causal Productions has used its best efforts to ensure that the templates have the same appearance.

Causal Productions permits the distribution and revision of these templates on the condition that Causal Productions is credited in the revised template as follows: "original version of this template was provided by courtesy of Causal Productions (www.causalproductions.com)".

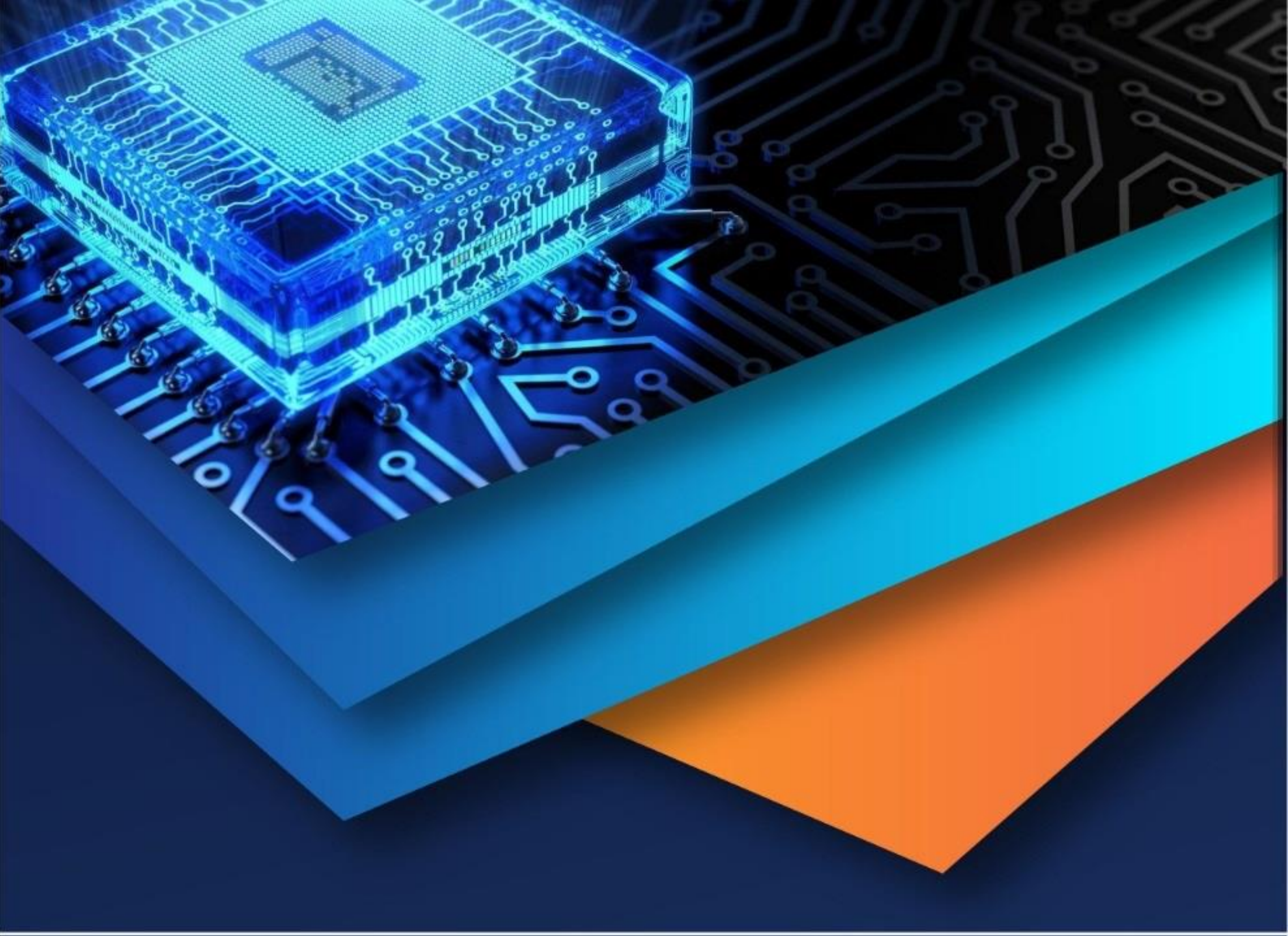
## VI. ACKNOWLEDGMENT

The heading of the Acknowledgment section and the References section must not be numbered.

Causal Productions wishes to acknowledge Michael Shell and other contributors for developing and maintaining the IEEE LaTeX style files which have been used in the preparation of this template. To see the list of contributors, please refer to the top of file IEEETran.cls in the IEEE LaTeX distribution.

## REFERENCES

[1] S. M. Metev and V. P. Veiko, Laser Assisted Microtechnology, 2nd ed., R. M. Osgood, Jr., Ed. Berlin, Germany: Springer-Verlag, 1998.
[2] J. Breckling, Ed., The Analysis of Directional Time Series: Applications to Wind Speed and Direction, ser. Lecture Notes in Statistics. Berlin, Germany: Springer, 1989, vol. 61.
[3] S. Zhang, C. Zhu, J. K. O. Sin, and P. K. T. Mok, "A novel ultrathin elevated channel low-temperature poly-Si TFT," IEEE Electron Device Lett., vol. 20, pp. 569–571, Nov. 1999.
[4] M. Wegmuller, J. P. von der Weid, P. Oberson, and N. Gisin, "High resolution fiber distributed measurements with coherent OFDR," in Proc. ECOC'00, 2000, paper 11.3.4, p. 109.
[5] R. E. Sorace, V. S. Reinhardt, and S. A. Vaughn, "High-speed digital-to-RF converter," U.S. Patent 5 668 842, Sept. 16, 1997.
[6] (2002) The IEEE website. [Online]. Available: http://www.ieee.org/
[7] M. Shell. (2002) IEEEtran homepage on CTAN. [Online]. Available: http://www.ctan.org/tex-archive/macros/latex/contrib/supported/IEEEtran/
[8] FLEXChip Signal Processor (MC68175/D), Motorola, 1996.
[9] "PDCA12-70 data sheet," Opto Speed SA, Mezzovico, Switzerland.
[10] A. Karnik, "Performance of TCP congestion control with rate feedback: TCP/ABR and rate adaptive TCP/IP," M. Eng. thesis, Indian Institute of Science, Bangalore, India, Jan. 1999.
[11] J. Padhye, V. Firoiu, and D. Towsley, "A stochastic model of TCP Reno congestion avoidance and control," Univ. of Massachusetts, Amherst, MA, CMPSCI Tech. Rep. 99-02, 1999.
[12] Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specification, IEEE Std. 802.11, 1997.




10.22214/IJRASET

INDEX COPERNICUS 45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429


# INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY