iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** V **Month of publication:** May 2019

DOI: https://doi.org/10.22214/ijraset.2019.5312

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue V, May 2019- Available at www.ijraset.com

Analysis and Design of B+G+10 Commercial High-rise Building under Seismic Load and Wind Load by Using Software

Virendra K. Tembhare[1], Prof. Dilip L. Budhalani[2]
[1]M. Tech. (Structural Engineering) Scholar, [2]Associated Professor, Department of Civil Engineering, Guru Nanak Institutes of Engineering & Management, Kalmeshwar, Nagpur, Maharashtra – 441501, India.

Abstract: High-rise buildings are necessary to construct as a worldwide architectural phenomenon. The behaviour of the structures during seismic load and wind loads has a major role, not only from structural engineering point of view, but also safety of humans living in the structure. It is a challenge for designer to study the impact and performance of High-rise structures under wind and seismic loading. In this paper, the analysis and design of High-rise buildings under wind and seismic load as per IS codes recommended. Seismic analysis with response spectrum method and wind load analysis with gust factor method are used for analysis of a B+G+10-storey RCC high rise building as per IS 1893(Part1):2002 and IS 875(Part3):1987 codes respectively. The building is modelled in 3D using STAAD. Pro. software. In this Analysis, B+G+10 storied building is considered and applied various loads like static load, wind load, earthquake load and results are studied and design the building. In this Analysis, the height of building is approximate 38.5 meter high. Safety of the structure is checked against allowable limits in inter-storey drifts, base shear in codes of practice described and other literature for earthquake and wind. All dynamic parameter such as torsion in column, change in reinforcement of column, displacement of mass C.G., change in bending moment, shear force and axial force in column and change in stresses of beam are analysed and summaries its governing condition.
Keywords: High-rise Building, Earthquake load effect, Wind load Effect.

I. INTRODUCTION

Buildings are defined as structures used by the people as shelter for living, working or storage purpose. With fast growth in population along with the development of social activities rapid urbanization has taken place which has resulted into continuous movement of rural people to metro cities. High-rise buildings, which are normally designed for office or commercial as well as residential purpose, are among the most distinguished space definitions in the architectural history. They are primarily a reaction to the fast growth of the urban population and the demand by business activities to be as close to each other as possible. Today, it is not possible to imagine a major city without tall buildings. The importance of high-rise buildings in the contemporary urban development is without doubt ever increasing despite their several undeniable unfair effects on the quality of urban life.

In general, multi-storey buildings need to be designed for wind as well as earthquake loads for the tough condition. Governing criteria for carrying out dynamic analyses for earthquake load is dissimilar from wind load. According to the provisions of Bureau of Indian Standards for earthquake load, IS 1893(Part 1):2002, height of the structure, seismic zone, soft and weak storey required dynamic analysis for earthquake load. Load exerted on the building envelope are transferred to the structural system, where in turn they must be transferred through the foundation into the ground, the magnitude of the pressure is a function of the following primary factors: exposed basic wind speed, topography, building height, internal pressure, and building shape. When wind pressures act on building, both positive and negative pressures fall out simultaneously, the building must have sufficient strength to resist the applied loads from these pressures to prevent wind cause building failure.

A. Review of Literature

K. Ramaraju, M.I. Shereef et, al. (2013) Evaluated the response of 40 storey high Reinforced Concrete (RC) Building with Structural Engineering software under wind and seismic loads as per IS codes of practice using limit state method of analysis and design. Safety of structure was checked against allowable limits of prescribed for base shear, roof displacements, inter storey drifts, accelerations as prescribed in codes of practice and other relevant reference in literature. As they objected in their study for great scope regarding wind and seismic loads, identification for sensitivity of base shear of the building with respect to the location of the building at different wind zones in India is investigated.

Dr. K. R. C. Reddy, Sandip A. Tupat (2014) Analysed 12 storeys RC framed structure with estimations of wind and earthquake for various seismic zones. They described from their study, that wind and earthquake loads were increased with the effect of their behaviour with top increasing number of plates in the structure. They also addressed that critical level of wind loads were more dangerous than that of earthquake loads of tall structure in design criteria of building. They did mention important term that, structure should be designed for loads obtained in both directions independently for critical forces of wind or earthquake.

B. Objective & Scope

The main purpose of this work is to study the behaviour of a high rise building structure under the various actions of seismic loads and wind loads and analysis the behaviour of the structure. In this research, the concept of high rise building, which include the definition, basic design considerations of the load, and various lateral loads; shape modifications of tall buildings, are studied. Based on project, study was undertaken to determine the extent of possible changes in the seismic behaviour of RC Building Models. Further work can also be done on high-rise buildings and come to conclusion with analysis and design under given condition for wind and earthquake loads.

II. DEFINITION OF HIGH-RISE BUILDING

The high-rise building can be described as a multi-storey building generally available with high-speed elevators, using a structural frame construction, and combining height with available room spaces such as could be found in low-buildings. In aggregate, it is a physical, economic, and technological expression of the city's power base, representing its private and public investments for fulfilment of necessity of space.

A. Wind Effects act on High-Rise Buildings

The wind is the powerful and irregular force affecting high rise buildings at all direction. High-rise building can be defined as a drop anchored in the ground, bending and swaying in the wind along horizontal. This movement, known as *wind drift,* should be kept within permissible limits. Wind loads on buildings most increase considerably with the increase in building heights. Furthermore, the speed of wind increases with the height of building, and the wind pressures increase as the square of the wind speed act on surface of building. Thus, wind effects on a high-rise building are compounded as its height increases, cause wind effect vary according to different high of building. Wind is remaining a complex phenomenon, mainly according to two major problems. Unlike dead loads and live loads, wind loads change fast and even sudden, creating effects much larger than when the same loads were applied continuously, and that they limit building accelerations below human sensing.

B. Wind Speed Variation Accordance with Height

An important characteristic of wind is the variation of its speed with height shown in Figure 1. The wind speed increase follows a curved line varying from zero at the ground level surface to a maximum at particular distance above the ground level surface. The height at which the speed restrained to increase the speed, this height is called as the *gradient height,* and the corresponding speed is called as the *gradient wind speed.* This important characteristic of wind speed is a well understood phenomenon that higher design wind pressures are specified at particular higher elevations in most building codes as per given. Additionally, at heights of approximately 366 m from the ground, surface friction has an almost less or negligible effect on the wind speed. As such the wind force movement is only depending on the prevailing seasonal effect and local wind effects. The height of wind pressure through which the wind speed is affected by the topography atmosphere is called *atmospheric boundary layer.* The wind speed profile at this layer is in the domain of turbulent flow and could be mathematically calculated by such given formula as per recommended Codal provision.

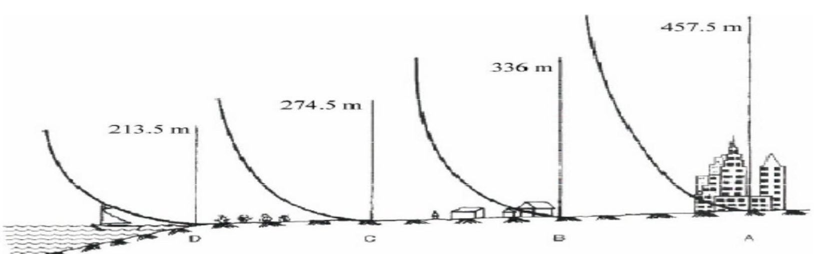


Figure 1. Variation of wind speed with height

C. Vortex-Shedding Phenomenon For Wind Pressure

Along wind pressure and across wind pressure are two important terms, used to explain the vortex-shedding phenomenon for wind pressure. Along wind or simply wind is the term used to refer to drag forces of wind pressure. The across wind response is a motion, which happens on a plane perpendicular to the direction of wind. When a building is subjected to a wind flow, the originally parallel wind stream lines are displaced on both transverse sides of the building (Fig 2), and the forces produced on these sides are called vortices

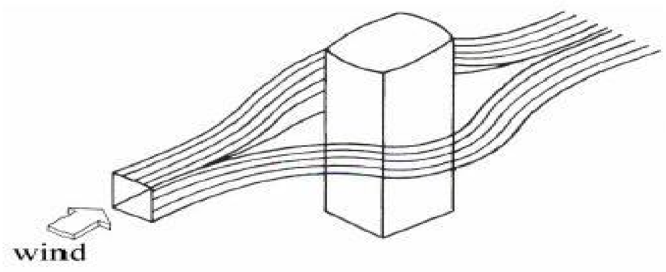


Fig 2. Simplified wind flow

At quite a low wind pressure, the vortices are shed symmetrically on both side of the building (Fig 2 a), and so building does not vibrate in the across wind direction due to wind pressure.

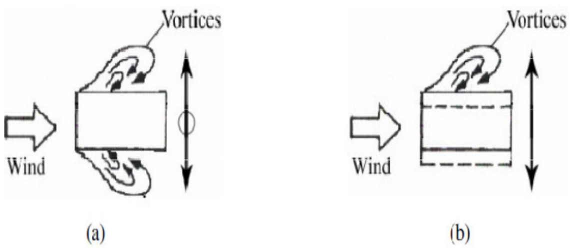


Fig 2. Vortices in different wind speed conditions: (a) vortices in low speed of wind pressure (there is no vibration in the across wind direction toward building); (b) vortices in high speed of wind – vortex-shedding phenomenon (there is vibration in the across wind pressure direction)

On the other hand, at higher wind speeds, the vortices are shed alternately first from one side and then from the other side of building. When this occurs, there is an impulse both side in the along wind and across wind directions of building. The across wind impulses are applied to the left side of building and then alternatively to the right side of building. Therefore such kind of shedding which causes structural vibrations in the flow of wind pressure and the across wind direction is called *vortex-shedding*, a phenomenon well known in fluid mechanics study. This phenomenon of alternate shedding of vortices for a rectangular high rise building is shown schematically in Figure 2b.

D. Earthquake Effects on High-Rise Buildings

As earthquakes can happen almost anywhere, some measure of earthquake resistance in the form of reserve ductility and redundancy should be generate in the form of design of all structures to prevent catastrophic failures. During the life of a building in a high seismic zone, it is usually expected that the earthquakes affect the many small building subjected to high seismic zone, including some moderate ones or more large ones. Building massing, shape and proportion, ground acceleration, and the dynamic response of the structure, variation of the magnitude and distribution of earthquake forces to the building. Therefore, two general approaches are used to determine the seismic loading on the building, which take into consideration the properties of the structure, and the previous record of earthquakes in the region according to the zone wise area. When comparison between earthquake load and wind loads, earthquake loads have stronger intensity and shorter duration to the structure.

E. High-Rise Building Behaviour During Earthquakes occur

Seismic motion response of high-rise buildings is to some extent generally different than low-rise buildings at the high seismic zone. In an earthquake the magnitude of inertia forces generated on the building mass, ground acceleration, the nature of foundation, and the dynamic characteristics of the structure (Figure 3) accordance with the height of building. Although high-rise buildings are more flexible than low-rise buildings in an earthquake load, and usually experience accelerations much less than low-rise ones, a high-rise building subjected to ground motions for a period may experience much larger forces if its natural period is near that of the ground waves.

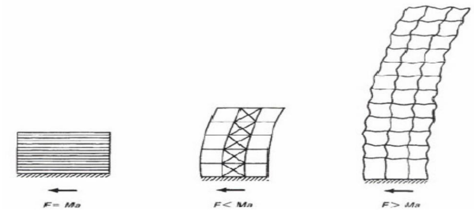


Figure 3.Schematic representation of seismic force

III. DESIGN CONSIDERATIONS

A. Types Of Load Used

1) *Dead Load (DL):* All permanent constructions of the structure form the dead loads are the self weight of the material weight of building. The dead load comprises of the weights of walls, partitions floor finishes, false ceilings, staircase loading, false floors and the other permanent constructions in the buildings. The dead load loads may be calculated from the dimensions of various members and their unit weights. The unit weights of plain concrete and reinforced concrete may be taken as 24 kN/m and 25 kN/m respectively. The density of brick masonry is 20 kN/m.
2) *Live Load (LL):* Imposed load is produced by the intended use or occupancy of a building including the weight of movable partitions and unstable load, distributed and concentrated loads, load due to impact and vibration and dust loads. Imposed loads do not include loads due to wind, seismic activity, snow, and loads imposed due to temperature changes to which the structure will be subjected to, creep and shrinkage of the high rise structure, the differential settlements to which the structure may undergo.
3) *Wind Load (WL):* Wind is air in motion relative to the surface of the earth affect to vertical portion. The primary cause of wind is traced to earth's rotation and differences in terrestrial radiation activity. The radiation effects are primarily responsible for convection upwards or downwards as well as horizontally affected. The wind generally blows horizontal to the ground at high wind speeds. Since vertical components of atmospheric motion are relatively small, the term 'wind' denotes almost exclusively the horizontal wind surface, vertical winds surface are always identified as such. The wind speeds are measured with the aid of anemometers or anemographs which are installed at meteorological observatories at heights generally varying from 10 to 30 meters above ground. It is help to measure the wind pressure at any efficiency.

Design Wind Speed, Vz [IS 5.3]

$Vz = Vb \times k1 \times k2 \times k3$

Where,

Vb = design wind speed at any height z in m/s;

kl = probability factor (risk coefficient)

k2 = terrain, height and structure size factor and

k3 = topography factor

Design Wind Pressure, Pz [IS 5.4]

$Pz = 0.6Vz^2$

4) *Seismic Load (SL):* Seismic load can be calculated taking the acceleration response of the ground to the super structure. According to the severity of earthquake intensity they are divided into 4 zones in India.

a) Zone I and II are combined as zone II
b) Zone II

c) Zone IV
d) Zone V

The Design base shear
(Vb) = Ah x W [IS 1893(Part I):2002, clause 7.5.3]
Ah = design horizontal acceleration in the considered direction of vibration=
(Z/2) x (I/R) x (Sa /g)[IS 1893(Part I):2002, clause 6.4.2]
W = total seismic value of the building
The design base shear (Vb) computed shall be distributed along the height of the building as per the following expression (BIS1893: 2000)

$$Q_i = V_B \frac{W_i h_i^2}{\sum_{j=1}^{n} W_j h_j^2}$$

Where,
Qi is the design lateral forces at floor i,
Wi is the seismic weights of the floor i, and
Hi is the height of the floor i, measured from base

5) Load Combinations

For seismic load analysis of a building the code refers following load combination.
a) 1.5(DL + IL)
b) 1.2(DL + IL ± EL)
c) 1.5(DL ± EL)
d) 0.9 DL ± 1.5 EL

For wind load analysis of a building the code refers following load combination
a) DL +LL
b) DL+WL
c) DL+0.8LL+0.8WL

Both WL and EL are applied in X and Z direction. These loads are also applied further in negative X and Z direction.

IV. PRILIMINARY DATA REQUIRED FOR THE ANALYSIS OF THE STRUCTURE.

1) *Type of Structure:* - multi-storey fixed jointed plane frame.
2) Seismic zone II (IS 1893-part 1: 2002)
3) Number of stories (B+G+10)
4) Floor height 3.0 m
5) Imposed load 2 KN/m2 on each floor and 1.5 KN/m2 on roof
6) Materials: - Concrete (M 30) and Reinforcement (Fe500)
7) Size of column 500 mm x 600 mm
8) Size of beam 350 mm x 500 mm
9) Depth of slab 125 mm thick
10) *Type of soil:* - Medium soil
11) Response spectra As per IS 1893

V. CONCLUSIONS

In this review paper, the study of behaviour or response of high-rise building under wind and seismic load as per IS code of practice are studied. Seismic analysis with response spectrum method and wind load analysis with gust factor method are used for analysis of a B+G+10 storey RCC high rise building as per is 1893(part1):2002 and is 875(part3):1987codes respectively.

REFERENCES

[1] Prof. Priyabrata Gupta, Anupam Rajmani, et,al, “Analysis of Wind & Earthquake load for different of High Rise Building”, International Journal of Civil Engineering and Technology (IJCIET) Vol.6, Issue 2, February 2015.

[2] K. RamaRaju, M.I. Shereef, et,al., “Analysis And Design Of RC Tall Building Subjected To Wind And Earthquake Loads”, 2 Proc. of the 8th Asia-Pacific Conference on Wind Engineering (APCWEVIII), ISBN: 978-981-07-8011-1. December 10, 2013.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.

[3] Dr. R.S. Talikoti , Shraddha J. Patil,Mahesh Z, Mali, “Effect of Wind Load on High Rise Structure”, International Journal of Engineering and Technical Research (IJETR) Vol.3, Issue 7, July 2015.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.

[4] Prof. S. S. Patil , S. A. Ghade, “Seismic Analysis of High-Rise Building by Response Spectrum Method”, IJCER International Journal of Engineering Research (Ijceronline.com) Vol.3, March 2013.

[5] Dr. K. R. C. Reddy, Sandip A. Tupat, “The Effect of zone factors on wind and earthquake loads of high-rise structures”, IOSR Journal of Mechanical and Civil Engineering (IOSR-JMCE), e-ISSN: 2278- 1684,P-ISSN: 2320-334X, 2014.

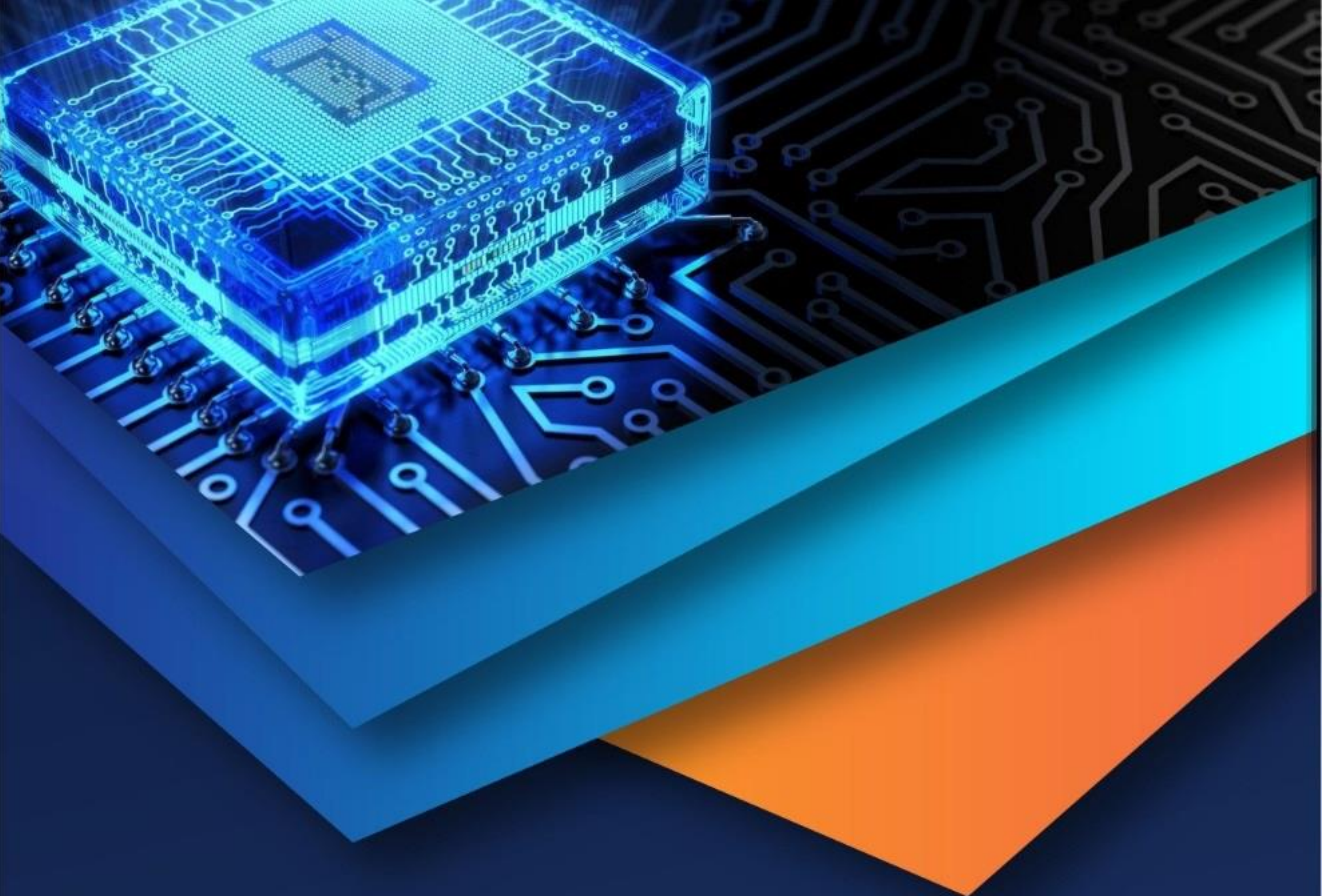
[6] Rupali Kavilkar, Shweta Patil, “Study of High-Rise Residential Buildings in Indian Cities”, IACSIT International Journal of Engineering and Technology, Vol. 6, No.1 February 2014.

[7] Mohammed Rizwan Sultan, D. Gouse Peera, “Dynamic Analysis of Multi –Storey Building for Different Shapes”, IJIRAE International Journal of Innovative Research in Advanced Engineering, ISSN:2349-2163.

[8] Borugadda Raju, R. Rattaiah, “Analysis and Design of High-Rise Building (G+30) Using STAAD. Pro”, IJRSAE International Journal of Research Science and Advanced Engineering, vol.2, Oct-dec. 2015.

[9] Mahdi Hosseini, N. V. Ramana Rao, “Earthquakes Analysis of High-Rise Buildings with Shear Walls at Centre Core and Centre of Each Side of the External Perimeter with Opening”, IJSR International Journal of Science and Research, ISSN (Online):2319-7064, 2016.

[10] Anoop Singh, Vikas Shrivastava, et, al., “Seismic Analysis and Design of Building Structures ``in STAAD Pro”, IJRIRSET International Journal of Innovative Research in Science, Engineering and Technology, ISSN: 2347-6710, July 2016.



10.22214/IJRASET

INDEX COPERNICUS
45.98

IMPACT FACTOR:
7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR:
7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY