Seismic Analysis of Horizontally & Vertically Irregular RC Building With & Without Bracing Under Different Seismic Zones

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Abstract: Many buildings in the present scenario have irregular configurations both in plan and elevation, in future these buildings may be subjected to devastating earthquakes. In such a case, it is necessary to identify the performance of the structures to withstand against disaster for both new and existing one. Structures experience lateral deflections under seismic loads, Magnitude of these lateral deflections is related to many variables such as structural system, mass of the structure and effects in the structural materials. In present work, a combined seismic analysis of Horizontal irregularity i.e. Plan irregularity and Vertical irregularity i.e. Mass irregularity along with provision of bracing and without bracing is studied. Dynamic analysis i.e. Response spectrum is carried out in 10, 15, 20 storey building. Here the analysis of structure is carried out using ETABS 2016 software. Outcome of this analysis is discussed in terms of Storey displacement & Base shear.

Index Terms **– Horizontal irregularity, Plan irregularity, Vertical irregularity, Mass irregularity, Response Spectrum.**

I. INTRODUCTION

Nowadays population is a major problem and is increasing day by day thus resulting in construction of more vertical housing due to shortage of land. Earthquake is a common disastrous phenomenon that each and every structure on earth may suffer to certain damage. The seismic waves effect the building more violently that leads to building collapse. Earthquakes are carefully studied by many scholars in previous years, took much time to estimate the earthquakes also these earthquakes are most anticipated. The aim of the structural engineer is to know the reason of building collapse and find out appropriate solution for that may be designing a structure to withhold the lateral forces.

The performance of building during an earthquake depends upon several factors, such as stiffness, mass, geometry and regular configuration. The failure of structure starts at points of weakness. This weakness arises due to discontinuity in mass, stiffness and geometry of structure. A building is said to be a regular when the building configurations are almost symmetrical about the axis and it is said to be the irregular when it lacks symmetry and discontinuity in geometry, mass or load resisting elements. Under seismic force many structures are failed due to presence of irregularities but regular configuration structures are performed better during seismic loading.

II. OBJECTIVES

- To compare Horizontal irregular frame with Regular frame.
- To compare Vertical irregular frame with Regular frame.
- To compare combine effect of Horizontal irregularity & Vertical irregularity with Regular frame.
- To analyze the structure with & without Bracing.

III. LITERATURE REVIEW

[9] Ravi Kiran, Sridhar.R investigated that the values for horizontal irregular building is 35.713% more and vertical irregular building is 58.143% more when compared to regular building for maximum displacement.

[6] N.Anvesh, Dr. Shaik Yajdani, K. Pavan Kumar investigated that there is an increase of 67% in the moments of mass irregular buildings than buildings without mass irregularity.

[5] Md Shehzad Choudhary, Syed Arfath, Md Mansoor Ahmed, Nadeem Pasha investigated that there is increase in displacement with increase in variation of slab thickness.

[11] Vishwanatha S N, D S Sandeep Kumar investigated that displacement was more in composite building as compared to conventional RCC building and maximum in composite mass irregular building.

[3] Dileshwar Rana, Prof. Juned Raheem investigated that the critical seismic parameter of 4 bay buildings up to eight storey building height is less than corresponding 8 bay building.

IV. METHODOLOGY

In the present work the analysis of following structures with different type of shapes are been carried out:

- Regular
- L Shape
- Regular + Mass
- L + Mass

The Beam, Column & Brace dimensions vary with different storey height. The plan areas of the all the structures are kept same. The materials such as Poisson ratio, Density of RCC, Density of Masonry, Young's modulus, compressive strength of steel and concrete etc. are also kept constant in all buildings. The steps are followed for the analysis purpose, the below are the steps which carry out the whole analysis and description of the procedure.

Response Spectrum

a) Regular Building

i) 10 Storey Building

ii) 15 Storey Building

iii) 20 Storey Building

b) Building with Irregularity (L, Regular + Mass, L+ Mass)

i) 10 Storey Building

ii) 15 Storey Building

iii) 20 Storey Building

Comparison of the parameters considered in the study of regular as well as the irregular type structures.

- The analysis is carried out for soil condition II.
- The analysis is carried out for different seismic zones (IV and V).
- The result parameters includes Displacement & Base Shear which are to be compared.

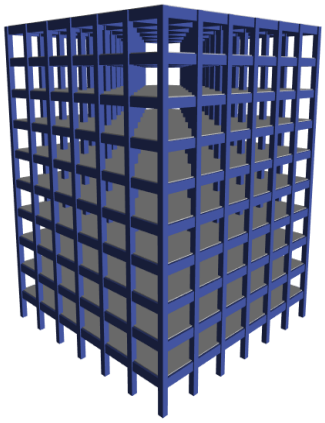
Structure and Section details:

Plan dimension	24 mx 24 m
Number of bays in X & Y direction	6 nos.
Bay length in X & Y direction	4m
Height of the floor	3m
Grade of concrete	M 35
Grade of steel	Fe- 500
Slab thickness	150 mm
Dead load	Default values taken by Etabs
Live load	4 KN/m^2
Extra live load for mass irregular structure	13 KN/m^2 @ every 5^{th} floor
Floor finish	1.5 KN/m^2
Wall load	13.8 KN/m
Parapet wall load	4.6 KN/m
Importance Factor (I)	1
Response Reduction Factor (R)	5

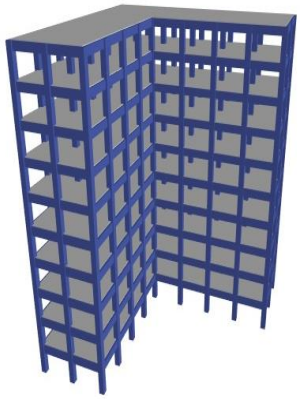
PARAMETERS	10 STOREY	15 STOREY	20 STOREY
Column	600mm x 600mm	C1 – 750mm x 750mm C2 – 550mm x 550mm C3 – 500mm x 500mm	C1 – 800mm x 800mm C2 – 700mm x 700mm C3 – 600mm x 600mm C4 – 500mm x 500mm
Beam	B1 – 400mm x 800mm B2 – 300mm x 750mm	B1 – 400mm x 750mm B2 – 350mm x 700mm B3 – 300mm x 650mm	B1 – 450mm x 900mm B2 – 400mm x 800mm B3 – 350mm x 650mm
Column for Braced section	550mm x 550mm	C1 – 700mm x 700mm C2 – 500mm x 500mm C3 – 450mm x 450mm	C1 – 750mm x 750mm C2 – 650mm x 650mm C3 – 500mm x 500mm C4 – 400mm x 400mm
Beam for Braced section	B1 – 400mm x 700mm B2 – 300mm x 650mm	B1 – 400mm x 750mm B2 – 350mm x 700mm B3 – 300mm x 650mm	B1 – 450mm x 900mm B2 – 400mm x 800mm B3 – 350mm x 650mm
Bracing	Brace 1 – 400mm x 400mm Brace 2 – 350 mm x 350mm	Brace 1 – 400mm x 400mm Brace2 – 350 mm x 350mm	Brace – 350mm x 350mm

NOTE :-

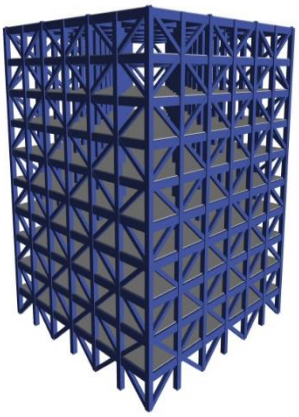
- For 10 storey building B1 is provided from 1st to 5th floor & B2 is provided from 6th to 10th floor.
- For 10 storey braced building Brace 1 is provided from 1st to 5th floor & Brace 2 is provided from 6th to 10th floor.
- For 15 storey building C1 B1 is provided from 1st to 5th floor, C2 B2 is provided from 6th to 10th floor & C3 B3 is provided from 11th to 15th floor.
- For 15 storey braced building Brace 1 is provided from 1st to 5th floor & brace 2 is provided from 6th to 15th floor.
- For 20 storey building C1 B1 is provided from 1st to 5th floor, B2 is provided from 6th to 15th floor, C2 is provided from 6th to 10th floor, C3 is provided from 11th to 15th floor & C4 B3 is provided from 15th to 20th floor.



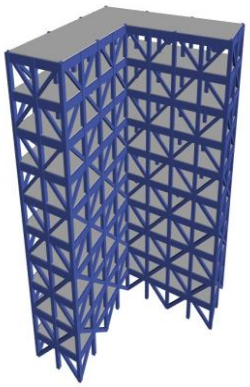
Regular Structure without Bracing (WOB)



L-shape Structure without Bracing (WOB)



Regular Structure With Bracing (WB)

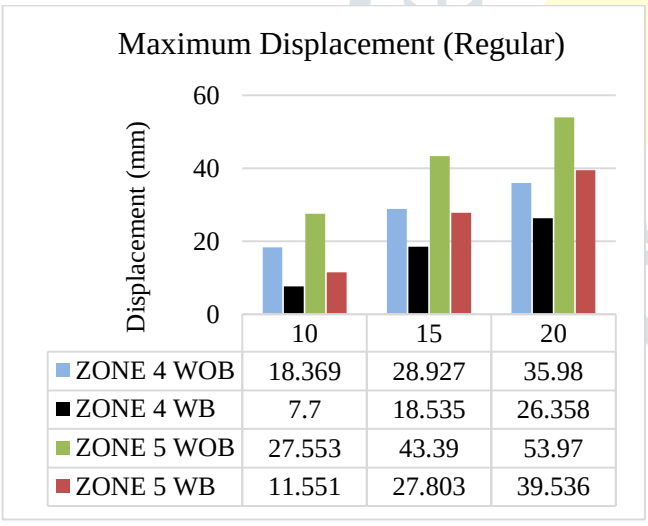


L-shape Structure With Bracing (WB)

V. RESULTS

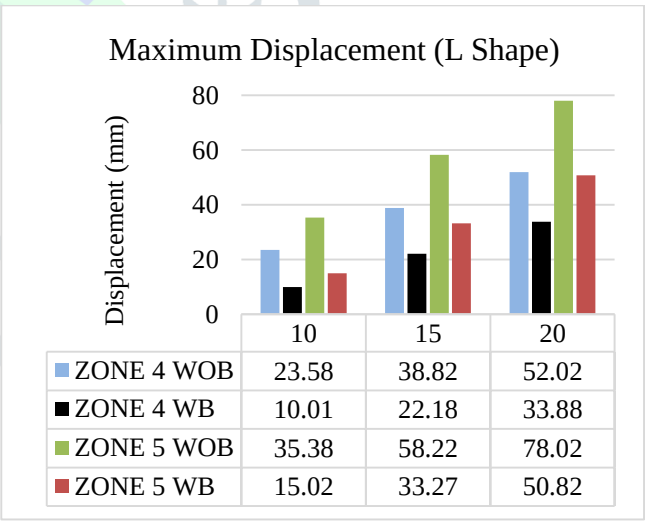
The analysis results of Regular, L - shape, Regular + Mass, L+ Mass structure subjected to seismic forces in Zone IV and V are as below of with and without Bracing.

- **Maximum Displacement**



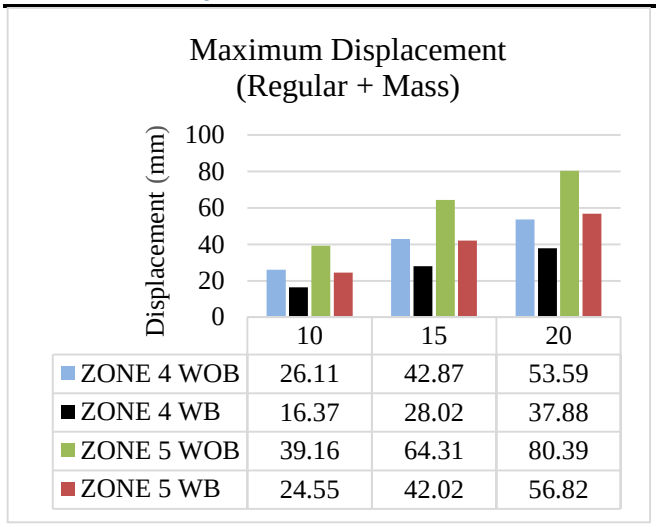
	10	15	20
ZONE 4 WOB	18.369	28.927	35.98
ZONE 4 WB	7.7	18.535	26.358
ZONE 5 WOB	27.553	43.39	53.97
ZONE 5 WB	11.551	27.803	39.536

Maximum Displacement of Regular structure



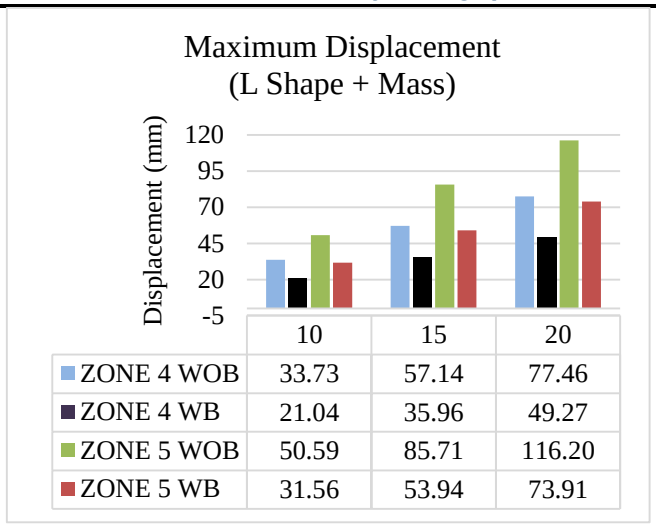
	10	15	20
ZONE 4 WOB	23.58	38.82	52.02
ZONE 4 WB	10.01	22.18	33.88
ZONE 5 WOB	35.38	58.22	78.02
ZONE 5 WB	15.02	33.27	50.82

Maximum Displacement of L – Shape Structure



	10	15	20
ZONE 4 WOB	26.11	42.87	53.59
ZONE 4 WB	16.37	28.02	37.88
ZONE 5 WOB	39.16	64.31	80.39
ZONE 5 WB	24.55	42.02	56.82

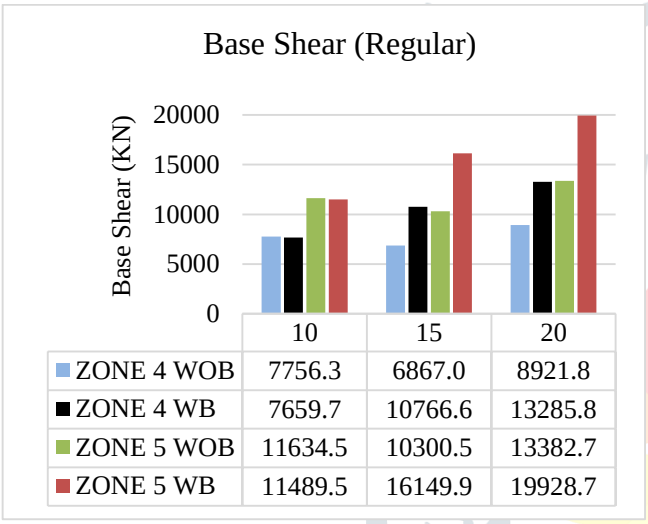
Maximum Displacement of Regular + Mass structure



	10	15	20
ZONE 4 WOB	33.73	57.14	77.46
ZONE 4 WB	21.04	35.96	49.27
ZONE 5 WOB	50.59	85.71	116.20
ZONE 5 WB	31.56	53.94	73.91

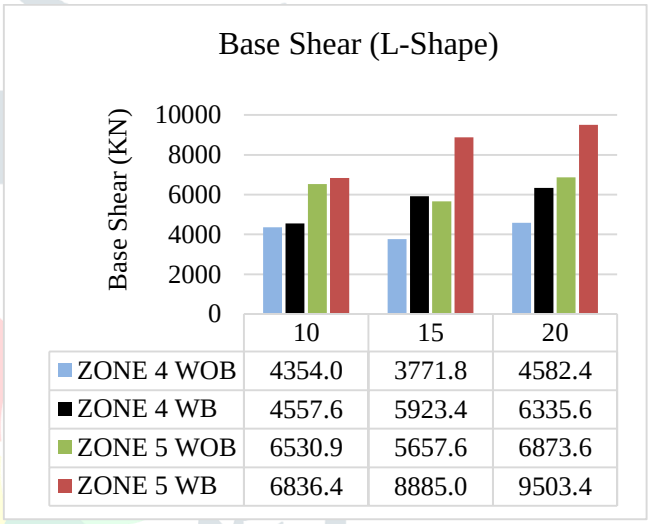
Maximum Displacement of L – Shape + Mass Structure

- **Base Shear**



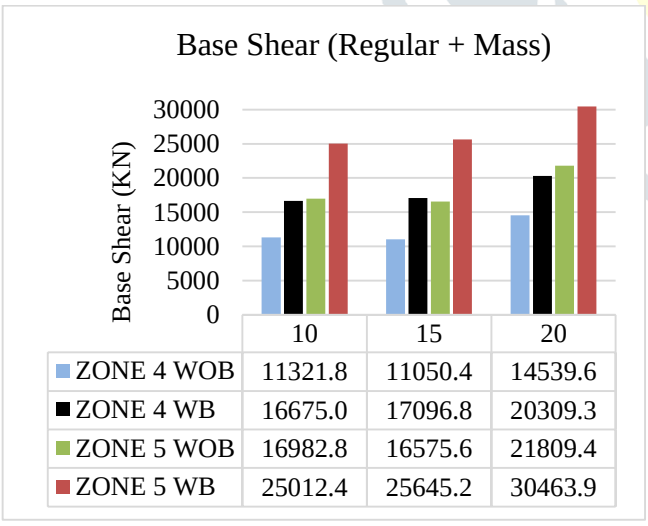
	10	15	20
ZONE 4 WOB	7756.3	6867.0	8921.8
ZONE 4 WB	7659.7	10766.6	13285.8
ZONE 5 WOB	11634.5	10300.5	13382.7
ZONE 5 WB	11489.5	16149.9	19928.7

Base Shear of Regular Building



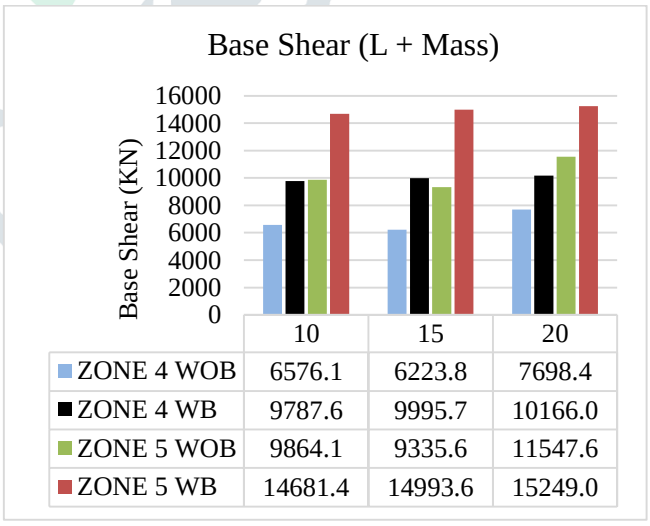
	10	15	20
ZONE 4 WOB	4354.0	3771.8	4582.4
ZONE 4 WB	4557.6	5923.4	6335.6
ZONE 5 WOB	6530.9	5657.6	6873.6
ZONE 5 WB	6836.4	8885.0	9503.4

Base Shear of L – Shape Building



	10	15	20
ZONE 4 WOB	11321.8	11050.4	14539.6
ZONE 4 WB	16675.0	17096.8	20309.3
ZONE 5 WOB	16982.8	16575.6	21809.4
ZONE 5 WB	25012.4	25645.2	30463.9

Base Shear of Regular + Mass Building



	10	15	20
ZONE 4 WOB	6576.1	6223.8	7698.4
ZONE 4 WB	9787.6	9995.7	10166.0
ZONE 5 WOB	9864.1	9335.6	11547.6
ZONE 5 WB	14681.4	14993.6	15249.0

Base Shear of L + Mass Building

I. CONCLUSION

- It is found that displacement results are **58.08%, 35.92%, and 26.74%** decreased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **Regular building**.
- It is found that displacement results are **57.55%, 42.86% & 34.87%** decreased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **L-Shape building.**
- It is found that displacement results are **37.31%, 34.66% & 29.31%** decreased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **Regular + Mass building.**
- It is found that displacement results are **37.62%, 37.06% & 36.39%** decreased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **L + Mass building.**
- It is found that Base Shear results is decreased by **1.25% for 10 storey building** & **56.79%, 48.91%** increased in case of Structure with Bracing compared to Structure without Bracing in **15 & 20 storey building** respectively for **Regular building.**
- It is found that Base Shear results are **4.68%, 57.05% & 38.26%** increased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **L-Shape building**.
- It is found that Base Shear results are 47.28%, 54.72% & 39.68% increased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **Regular + Mass building**.
- It is found that Base Shear results are **48.84%, 60.61% & 32.05%** increased in case of Structure with Bracing compared to Structure without Bracing in **10, 15 & 20 storey building** respectively for **L + Mass building**.

REFERENCES

Research paper:

1. Bharat Patel, Rohan Mali, Prataprao Jadhav, G. Mohan Ganesh. "Seismic Behaviour of Systems in High Rise Different Bracing RCC Buildings". International Journal of Civil Engineering and Technology, IJCIET, Volume: 08 Issue: 03 | March 2017
2. Chetan P. Agrawal, Amey R. Khedikar. "Seismic Analysis of High Rise RC Structure with Different Plan Configuration". International Journal of Research, IJR , International Conference on Innovation and Research in Engineering, Science & Technology Volume: 05 Issue:13| February 2018
3. Dileshwar Rana, Prof. Juned Raheem. "Seismic Analysis of Regular & Vertical Geometric Irregular RCC Framed Building International Research Journal of Engineering and Technology, IRJET, Volume: 02 Issue: 04 | July 2015
4. Malavika Manilal, Rajeeva S.V. "Comparative Study on the Seismic Response of RC Regular and Irregular Structures with Shear Wall". International Journal of Research and Scientific Innovation, IJRSI Volume: 04 Issue: 06 | June 2017
5. Md Shehzad Choudhary, Syed Arfath, Md Mansoor Ahmed, Nadeem Pash. "Comparative Study on Seismic Analysis of Multi Storey Building Having Diaphragm Discontinuity Using Etabs." International Journal of Research in Advent Technology, Volume : 06 Issue: 05 | May 2018
6. N.Anvesh, Dr. Shaik Yajdani, K. Pavan Kumar. "Effect of Mass Irregularity on Reinforced Concrete Structure Using Etabs." International Journal of Innovative Research in Science, Engineering and Technology, IJIRSET, Volume: 04 Issue: 10 | October 2015
7. Neha P. Modakwar, Sangita S. Meshram, Dinesh W. Gawatre. "Seismic Analysis of Structures with Irregularities". International Organization Of Scientific Research Journal of Mechanical and Civil Engineering, IOSR-JMCE, International Conference on Advances in Engineering & Technology, ICAET 2014
8. Oman Sayyed, Suresh Singh Kushwah, Aruna Rawat. "Seismic Analysis of Vertical Irregular RC Building with Stiffness and Setback Irregularities". International Organization Of Scientific Research Journal of Mechanical and Civil Engineering, IOSR-JMCE, Volume: 14 Issue: 01 | Jan.-Feb. 2017
9. Ravi Kiran, Sridhar.R. "Comparative study of regular and vertically irregular building under seismic loading." International Journal of Research in Engineering and Technology , IJRET Volume: 05 Issue: 09 | September 2016
10. Rupesh R Pawade, Dr.M.N. Mangulkar. "Influence of Combine Vertical Irregularities in the Response of Earthquake Resistance RC Structure". International Organization Of Scientific Research Journal of Mechanical and Civil Engineering, IOSR-JMCE, Volume: 14 Issue: 01 | Jan-Feb. 2017
11. Vishwanatha S N, D S Sandeep Kumar. "Seismic Analysis Of Multi-storeyed Rcc And Composite Building Subjected To Vertical Irregularity". International Research Journal of Engineering and Technology, IRJET, Volume: 05 Issue: 05 | May 2018