EFFECT OF HIGH STRENGTH CONCRETE COLUMNS ON STRUCTURAL BEHAVIOUR OF RCBUILDINGS (M40 GRADE)

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ABSTRACT:

High-rise structures are also called "vertical cities", having the potential to decongest urban sprawl. Indian cities are witnessing immense demographic expansion due to migration from surrounding villages, leading to urban sprawl, housing demand, rise in cost of land. Housing has developed into an economy generating industry. Given this demand, while high-rise residential structures have become a solution in the metropolitan cities, they remain eluded in tier II cities in India. Low-rise or mid-rise high density dwelling types have developed in these cities.The principle objective of this project is to analyses and design a multi-strayed building [G + 15] (3 dimensional frame)] using STAAD Pro. The design involves load calculations manually and analysing the whole structure by STAAD Pro. The design methods used in STAAD-Pro analysis are Limit State Design conforming to Indian Standard Code of Practice. STAAD. Pro features a state-of-the-art user interface, visualization tools, powerful analysis and design engines with advanced finite element and dynamic analysis capabilities. From model generation, analysis and design to visualization and result verification.

Strength, durability and stability are the main criteria for material selection and design in the construction industry. Consequently, development and enhancement of construction materials is always an active and attractive field for engineers and researchers. Elevated temperature (fire) is a potential threat for any structural buildings that can cause a major damage. Response of construction materials exposed to elevated temperature or fire requires a full study and analysis with lessons learned from previous cases. High strength concrete (HSC) has been used in the lower story columns of high rise buildings owing to its qualities over normal strength concrete (NSC) in many countries. But, the full structural qualities of the HSC were unable to be used because of insufficient information regarding the structural behaviour of the material and its properties.

1.0 INTRODUCTION

Concrete durability has been defined by the American Concrete Institute as its resistance to weathering action, chemical attack, abrasion and other degradation processes. Durability is the ability to last a long time without significant deterioration. A durable material helps the environment by conserving resources and reducing wastes and the environmental impacts of repair and replacement. Construction and demolition waste contribute to solid waste going to landfills. The production of new building materials depletes natural resources and can produce air and water pollution the design service life of most buildings is often 30 years, although buildings often last 50 to 100 years or longer. Most concrete and masonry buildings are demolished due to obsolescence rather than deterioration. A concrete shell can be left in place if a building use or function changes or when a building interior is renovated. Concrete, as a structural material and as the building exterior skin, has the ability to withstand nature's normal deteriorating mechanisms as well as natural disasters. Durability of concrete may be defined as the ability of concrete to resist weathering action, chemical attack, and abrasion while maintaining its desired engineering properties. Different concretes require different degrees of durability depending on the exposure environment and properties desired. For example, concrete exposed to tidal seawater will have different requirements than an indoor concrete floor.

The reactivity is potentially harmful Aggregates are as important as cement to form a concrete that is very useful in the construction of buildings. These materials are granular material ingredients of cement and mixes. The same materials constitute about 85% of concrete mixes, by weight. With these characteristics, it is necessary for the material engineer to exercise a responsible selection of these materials to acquire a study and durable mixture. Concrete is a result of a hardened product of carefully proportioned mixture of aggregates, cement, and water. In order to be useful in construction the product must meet minimum compressive and requirements which are determined through a Mechanical Test of Concrete with Aggregates mechanical test; and to check the strength of the concrete used for bridges, buildings, and other structures where the principal stresses are compressive cube samples were obtained and tested in compression testing machine. In this study, the standard specification from the Compression Testing Machine (CTM) will be used as a minimum compressive strength of 140 kg/cm2 per minute. In our project we made a cubes of different aggregates like Basalt, White Granite and Quartzite are used and we tested for 7days, 21days and 28 days in compressive testing machine. But our Kadapa district is rich in White Granite, Basalt stone and Quartzite stone and they are easily available. This study generally focused on the mechanical test such as the compressive and Strength of concrete with different aggregates which were available in our local quarry sites.

The study specifically we had the following objectives:

- ❖ To determine the compressive strength of concrete with different aggregates like White Granite is available in Guvvala Chervil, and Basalt is available in Yerramasu Palli Quarry Site, Quartzite is available in Kotha Road Bidiki
- ❖ To determine the compressive of concrete cubes were prepared with different source of aggregates.
- ❖ To determine the compressive strength of concrete with aggregates is tested under compressive testing machine.
- ❖ The results of compressive strength of concrete cube samples between the source of different aggregates after 7days, 21days, and 28 days of OPC.

Concrete has been since long a major material for providing a stable and reliable infrastructure. Concrete with compressive strengths of 20-40 N/mm² has been traditionally used in construction projects. With the demand for more sophisticated structural forms along with deterioration, long term poor performance of conventional concrete led to accelerated research for development of concrete which would score on all the aspects that a new construction material is evaluated upon : strength, workability, durability, affordability and will thus enable the construction of sustainable and economic buildings.

NEED OF THE STUDY:

The normal storied buildings and high rise buildings are very different. So, the activities involved starting from the planning stage will impact the completion of the project. It will require planning of urban infrastructure around the structure. A detailed planning will be required for the building services and utilities in all the stages of construction. The safety requirements, the management requirement all increases drastically. Other factors that favour this are:

1. Rapidly growing urban population that increased demand for tall buildings

2. At the expense of quality of life, the human factors being neglected.

3. To establish priorities for new research in this particular field.

4. The professionals must have the new information on high-rise buildings.

2.0 LITERATURE REVIEW:

[1] Chandurkar, Pajgade (2013) evaluated the response of a 10 storey building with seismic shear wall using ETAB v 9.5. Main focus was to compare the change in response by changing the location of shear wall in the multi-storey building. Four models were studied one being a bare frame structural system and rest three were of dual type structural system. The results were excellent for shear wall in short span at corners. Larger dimension of shear wall was found to be ineffective in 10 or below 10 stories. Shear wall is an effective and economical option for high-rise structures. It was observed that changing positions of shear wall was found to attract forces, hence proper positioning of shear wall is vital. Major amount of horizontal forces were taken by shear wall when the dimension is large. It was also observed that shear walls at substantial locations reduced displacements due to earthquake.

[2]Viswanath K.G (2010) investigated the seismic performance of reinforced concrete buildings using concentric steel bracing. Analysis of a four, eight, twelve and sixteen storied building in seismic zone IV was done using Staad Pro software, as per IS 1893: 2002 (Part-I). The bracing was provided for peripheral columns, and the effectiveness of steel bracing distribution along the height of the building, on the seismic performance of the building was studied. It was found that lateral displacements of the buildings reduced after using X-type bracings. Steel bracings were found to reduce flexure and shear demand on the beams and columns and transfer lateral load by axial load mechanism. Building frames with X- type bracing were found to have minimum bending as compared to other types of bracing. Steel bracing system was found to be a better alternative for seismic retrofitting as they do not increase the total weight of the building significantly.

[3] Chavan, Jadhav (2014) studied seismic analysis of reinforced concrete with different bracing arrangements by equivalent static method using Staad Pro software. The arrangements considered were diagonal, V-type, inverted V-type and X-type. It was observed that lateral displacement reduced by 50% to 60% and maximum displacement reduced by using X-type bracing. Base shear of the building was also found to increase from the bareframe, by use of X-type bracing, indicating increase in stiffness. Esmaili et al. (2008) studied the structural aspect of a 56 stories high tower, located in a high seismic zone in Tehran. Seismic evaluation of the building was done by non-linear dynamic analysis. The existing building had main walls and its side walls as shear walls, connected to the main wall by coupling of beams. The conclusion was to consider the time-dependency of concrete. Steel bracing system should be provided for energy absorption for ductility, but axial load can have adverse effect on their performance. It is both conceptually and economically unacceptable to use shear wall as both gravity and bracing system. Confinement of concrete in shear walls is good option for providing ductility and stability.

[4] Akbari et al. (2015) assessed seismic vulnerability of steel X-braced and chevron-braced Reinforced Concrete by developing analytical fragility curve. Investigation of various parameters like height of the frame, the p-delta effect and the fraction of base shear for the bracing system was done. For a specific designed base shear, steel-braced RC dual systems have low damage probability and larger capacity than unbraced system..

[5] Manafpour (2000) The p-delta effect is more dominant for smaller PGA values. Kappos presented new methodology for seismic design of RC building based on feasible partial inelastic model of the structure and performance criteria for two distinct limit states. The procedure is developed in a format that can be incorporated in design codes like Eurocode 8. Time-History (Non-linear dynamic) analysis and Pushover analysis (Non-linear Static analysis) were explored.

3.0 MATERIALS AND METHODS

DESIGN OF M40 GRADE CONCRETE:

The main aim of this project is to provide the general mix design for any grade of concrete, so that, this project contains the mix design for M40 grade of concrete, the mix shall be designed to produce the required grade of concrete having the designated workability, and characteristic compressive strength, which will not be less then the appropriate values as per by this project, the required mix design will be obtained by changing the corresponding values with respective areas. Then we can obtain the required mix design for different grades of concrete.

In this project, general mix proportion is providing us the general procedure for nay grade of concrete. In the field of construction, concrete is the main material made up of different type of materials. The concrete is of different grades and each grade of concrete is useful for different properties and place. Generally these are two type of concrete,

- By Designing
- By Adopting
- By designing the concrete mix, concrete is called as Design Mix Concrete.
- By adopting the concrete mix, concrete is called as Nominal Mix Concrete.

From the above two type of concrete, design mix concrete procedure is applied in this project. The mix design procedure shall be selected to ensure the workability of fresh concrete.

Design Mix Concrete

Design mix concrete is the type of concrete used in construction, to produce the grade of concrete having the required workability and characteristic strength nominal mix, will reduce the cement content which is used in concrete reduce the water cement ratio also will increase the strength. In this project, general procedure has been given for the concrete of grades very from this procedure of M40grade of concrete the different grades such as M40 to M40 has been obtained by changing the values as per Indian standard 10dis. so it is much easier to design the mix ratio for grade of concrete up to M40.

A TYPICAL MIX-DESIGN PROCEDURE FOR SAY, M40 (40 N/MM²) GRADE OF CONCRETE.

The Codes generally used are IS-456, IS-9103 & SP-23 (latest versions) along with relevant contract specs.

- **DESIGN STIPULATION:**
  - f_{ck} at 28 days = 40 N/mm^2
  - Max. size of aggregates = 20mm
  - Degree of workability = Compaction Factor of 0.95 & Slump of 100 to 150 mm as per IS-456.
  - Shape of aggregates = angular
  - Degree of Quality Control = very good
  - Type of exposure = Moderate (or choose as per site condition)
  - Max. water/ cement (w/c) ratio = 0.50 (refer IS-456)
  - Minimum cement content = say 300 kg (refer IS-456 & contract specification & adopt the higher of the two)

In this design, coarse aggregates considered is a blend of 20mm as well as 12 mm aggregates blended at a ratio of 60:40 i.e. 60% 20mm & 40% 12mm aggregates. This is a commonly adopted practice in various sites. Instead of 12mm, some use 12.5mm or 10mm aggregates also.

- **TEST DATA FOR MATERIALS:**
  - Grade of cement = OPC 43 grade (commonly used)
  - Specific gravity of cement = say, 3.15
  - Size of coarse aggregates = 20mm; Specific gravity of C.A. = say, 2.9; Water absorption = say, 0.45% (actual sp. gr. & water absorption are to be determined at site-laboratory periodically as per Inspection Test Plan)
  - Size of coarse aggregates = 12mm; Specific gravity of C.A. = say, 2.87; Water absorption = say, 0.75% (actual sp. gr. & water absorption are to be determined at site laboratory periodically as per Inspection Test Plan)

Fine- aggregates used is River sand of say, Zone-1. Specific gravity of F.A. = say, 2.65; Water absorption = say, 1.15% (actual sp. gr. & water absorption are to be determined at site laboratory periodically as per Inspection Test Plan)

The 3.1 proportions of ingredients of Trial Mix No.1 were adopted for casting purpose after observing the 7 & 28 days cube strengths

Ngradients	20 mm	12 mm	sand	water	Cement	admixture
Mass of aggreg-ates in SSD condition (kg)	747	495	684	157.25	425	4.25
Water Absorption	0.45	0.75	1.15	–	–	–
Moisture Content	0.1	0.14	0.22	–	–	–
Adjustment (%)	(0.1-0.45) = –0.35	(0.14-0.75) = –0.61	(0.22-1.15) = –0.93	–	–	–
Mass adjustment (kg)	(-0.35% of 747) = –2.61	(-0.61% of 495) = –3.02	(-0.93% of 684) = –6.36	+ 11.99	–	–
Adjusted mass (kg)	744.39	491.98	677.64	169.24	425	4.25

Table 3.2 Mix proportions of M40 obtained as per different Mix Design Methods

Sr. No.	Type of mix design	DOE	ACI	BIS	USBR
1.	W/C	0.38	0.38	0.38	0.40
2	Water content	164	164	164	176.28
3	Cement content	430	430	430	430
4	Fine aggregates	413.86	838.96	553.01	743.10
5	Coarse aggregates	1241.58	957	1283.55	1054.89
6	plasticizer	4.3	4.3	3.44	4.3

4.0 RESULTS

The following are analysis results of a building by applying earthquake loading and dead loading along X Y Z axis using STADD PRO.

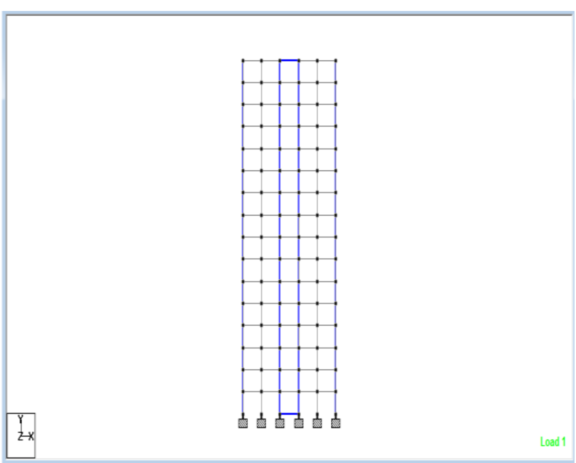


Figure 4.1 shows the design of a building using STADD PRO

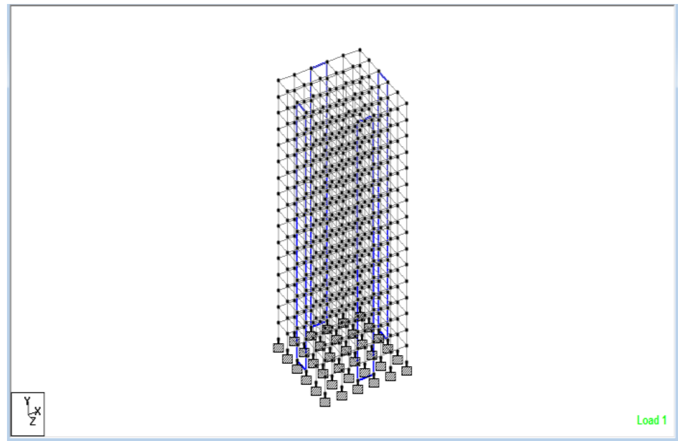


Figure 4.2 shows the earth quake load applying along X-axis on the building

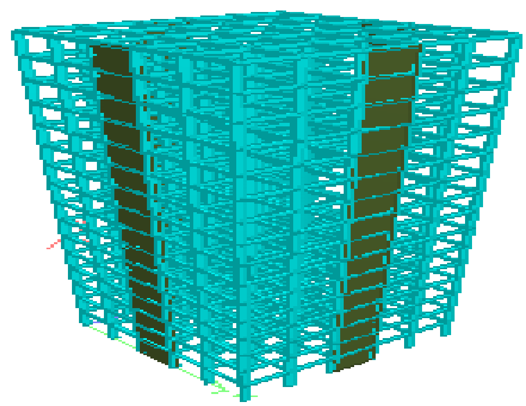


Figure 4.3 shows the 3-D module of a high raised building structure

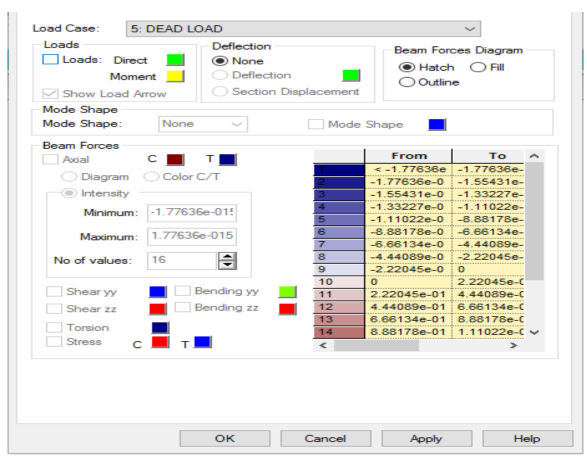


Figure 4.4 shows the applied DEAD LOADING on high raised building for analysis

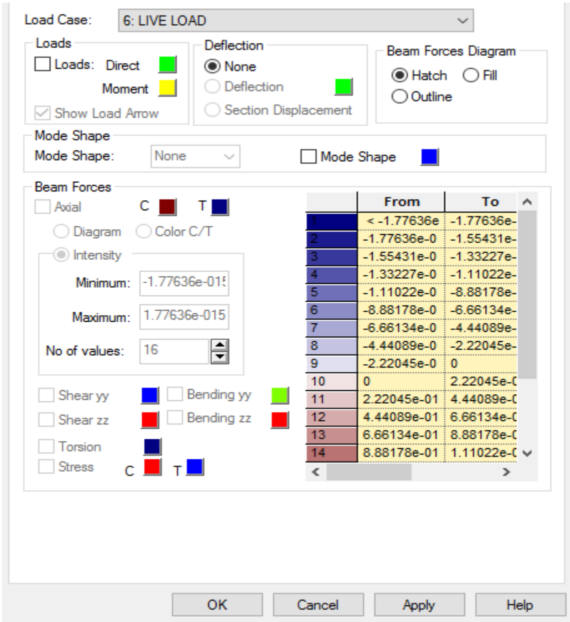


Figure 4.5 shows the LIVE LOADING on high raised building for analysis

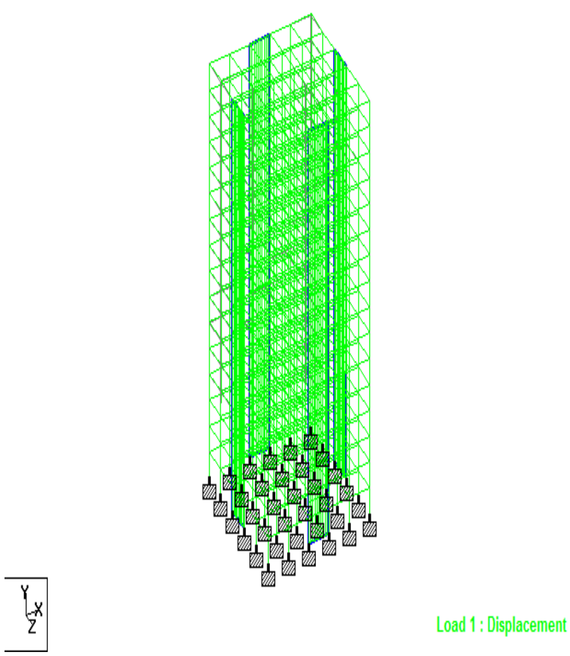


Figure 4.6 shows the analysis simulation of high raised building at applied earthquake loading along X-axis.

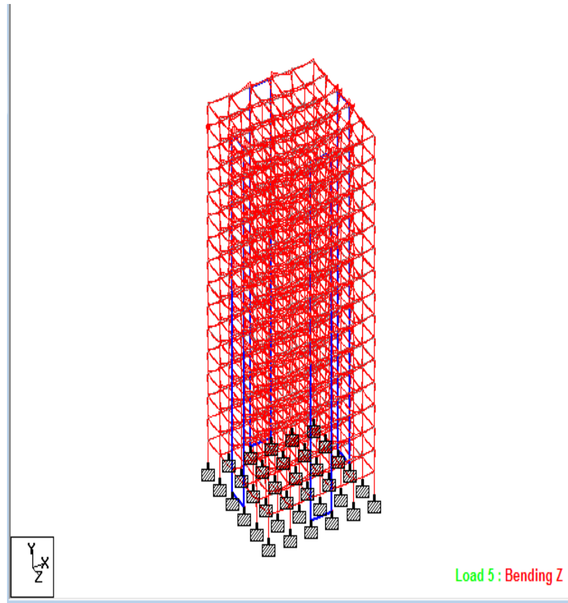
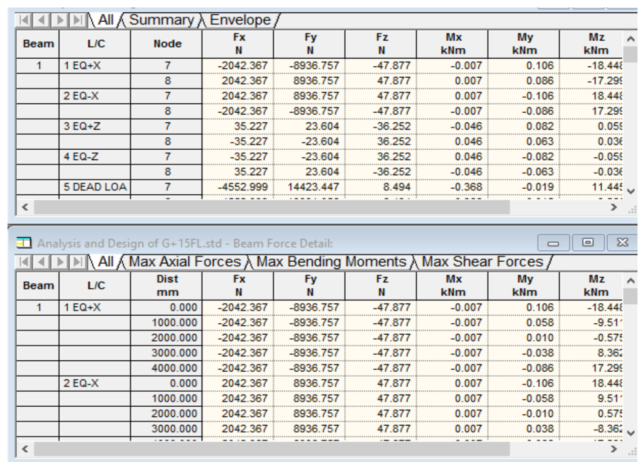


Figure 4.7 shows the bending analysis -of the high raised building at DEAD LOAD applied



Beam	L/C	Node	Fx N	Fy N	Fz N	Mx kNm	My kNm	Mz kNm
1	1 EQ+X	7	-2042.367	-8936.757	-47.877	-0.007	0.106	-18.448
		8	2042.367	8936.757	47.877	0.007	0.086	-17.29
	2 EQ-X	7	2042.367	8936.757	47.877	0.007	-0.106	18.448
		8	-2042.367	-8936.757	-47.877	-0.007	-0.086	17.29
	3 EQ+Z	7	35.227	23.604	-36.252	-0.046	0.082	0.05
		8	-35.227	-23.604	36.252	0.046	0.063	0.03
	4 EQ-Z	7	-35.227	-23.604	36.252	0.046	-0.082	-0.05
		8	35.227	23.604	-36.252	-0.046	-0.063	-0.03
	5 DEAD LOA	7	-4552.999	14423.447	8.494	-0.368	-0.019	11.44

Beam	L/C	Dist mm	Fx N	Fy N	Fz N	Mx kNm	My kNm	Mz kNm
1	1 EQ+X	0.000	-2042.367	-8936.757	-47.877	-0.007	0.106	-18.448
		1000.000	-2042.367	-8936.757	-47.877	-0.007	0.058	-9.51
		2000.000	-2042.367	-8936.757	-47.877	-0.007	0.010	-0.57
		3000.000	-2042.367	-8936.757	-47.877	-0.007	-0.038	8.36
		4000.000	-2042.367	-8936.757	-47.877	-0.007	-0.086	17.29
	2 EQ-X	0.000	2042.367	8936.757	47.877	0.007	-0.106	18.448
		1000.000	2042.367	8936.757	47.877	0.007	-0.058	9.51
		2000.000	2042.367	8936.757	47.877	0.007	-0.010	0.57
		3000.000	2042.367	8936.757	47.877	0.007	0.038	-8.36

Figure 4.8 shows the beam end forces and Beam Displacement analysis of DEAD LOAD

5.0 CONCLUSION:

The case study analysis puts forth that high rise residential buildings are not popular due to user perception that they are expensive and the associated fear of safety during fire. STAAD PRO is a versatile software has the capability to calculate the reinforcement needed for any concrete section, to find lateral deflection due to earthquake load. The program contains a number of parameters which are designed as per various structural action is consider on members such as axial, flexure, torsion etc according to their response.

Beam Design Output: The default design output of the beam contains flexural and shear reinforcement provided along the length of the beam.

Column Design: Columns are designed for axial forces, uniaxial and biaxial moments at the ends. Square columns are designed with reinforcement distributed on each side equally for the sections under biaxial moments and with reinforcement distributed equally in two faces for sections under uni-axial moment. All major criteria for selecting longitudinal and transverse reinforcement as stipulated by IS: 456 have been taken care of in the column design.

FUTURE SCOPE:

As per analysis, it is concluded that displacement as well as its stress also at different level in multi-storied building with shear wall is comparatively lesser as compared to R.C.C. building Without Shear Wall.So now a day we can-adopt -with shear wall at analyzed and optimized location. Less obstruction will be there because of reduced size of column and provision of shear wall. It is concluded that building with shear wall is constructed in lower cost as compared to structure without shear wall.

6.0 REFERENCES:

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