

o/c

**EXPERT COMMITTEE REPORT ON COLLAPSE OF
CANTILEVER PORTION OF COMMERCIAL BUILDING
AT SAMPIGE ROAD, MALLESWARAM,
BENGALURU**

2ND FEBRUARY 2017

Report for

**The Commissioner
Bruhat Bengaluru Mahanagara Palike
Bengaluru**

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1.0 PREAMBLE

The commercial building -Mantri mall, is a conventional RC framed structure with two basements, ground and three upper floors. The building is reported to be built during 2006-2008 and is in operation since 2008. It was reported that part of this commercial building (Mantri square mall) located at Malleshwaram, Bengaluru was collapsed at about 1.30 PM on Monday, 16th Jan 2017. In view of this, an expert committee was constituted by Commissioner, BBMP to investigate the causes of failure and to suggest suitable remedial measures wide ref no. Heniniyo/PR/ 1341/2016-17 dated: 17-01-2017 (Annexure-IV). The team carried out the study consisting of detailed physical examination, collection of samples, testing and review of structural drawings. Based on the study, the inferences and recommendations were made. This report gives details of the study carried out.

The scope of this study is limited to examination of the collapsed region of the structure, review of structural details of the collapsed region, arriving at reasons for collapse and recommending strengthening measures. In view of constraints of time and resources the study is limited only to collapsed region.

2.0 TEAM

The members of the committee are as follows.

1. Commissioner, BBMP, Chairman
2. Additional Director (Urban), Convener
3. Dr. Radhakrishna, Associate professor, R V College of Engineering, Member
4. Dr. K S Jayasimha, Head, Civil Aid Techno clinic Pvt Ltd, Member
5. Dr. R. Nagendra, Technical Director, Civil Aid Techno clinic Pvt Ltd, Member
6. Dr. M.S. Sudarshan, Senior Director, Civil Aid Techno clinic Pvt Ltd, Member.

The committee had its first meeting at office of BBMP (West), Malleshwaram on Wednesday, 18th Jan 2017. Later the committee visited the site and had preliminary inspection. The fractured portion was inspected from roof, intermediate floors and ground level. It was found that cantilever portions of the slab were collapsed from roof and III floor

(ph 1-6 of Annexure-1). Since it was not possible to closely inspect the fractured part, the inspection committee requested for providing a suitable platform/scaffolding. Other facilities such as videography, photography, relevant structural drawings, provision for core cutting with accessories etc. were also requested to carry out detailed inspection.

After providing the platform and other facilities the committee visited the site on Saturday, 21st Jan 2017 for a detailed inspection and sample collection.

3.0 DATES OF INSPECTION

The team inspected the site for inspection and collection of samples on the following dates:

1. Wednesday, 18.1.2017
2. Saturday, 21.1.2017
3. Monday, 23.1.2017
4. Monday, 30.1.2017

4.0 OBSERVATIONS

The following observations were made during the inspection:

1. The cantilever slabs of span 2 m are provided in the second, third and roof slab levels at the rear portion of the building. They intend to serve as fire exit pathway and access to services.
2. The collapse of a portion of cantilever roof slab and a portion of second floor balcony slab had occurred at the northwest corner of Mantri Mali Building.
3. The debris had fallen on ground at rear region of the building. Some portions of the slab, along with service cables were hanging in the collapsed region.
4. In the cantilever portion of the roof, two chiller pipes of 600mm diameter are placed on regular pedestal, carrying water.
5. In the northwest region, cantilever roof slab to a length of about 17 m had collapsed, along with the R.C. parapet. The collapse had created distress in the form of cracks in the remaining cantilever slab to a length of about 8m. These cracks were along the cantilever support.

6. Cracks were also observed in the RCC parapet wall which is existing near to the collapsed region.
7. It appears that the failure is first triggered in the roof and the debris fell on the third floor cantilever slab. This gave way due to the impact of the falling debris. However, the second floor cantilever slab suffered only the damage to the parapet and no visible distress was observed in the cantilever slab region.
8. The fractured section of the cantilevered roof slab shows the top layer of membrane waterproofing followed by screed concrete layer. A bituminous water proof layer was seen between the screed and RCC slab. The thickness of RCC slab was measured as 200mm and the thickness of screed concrete was measured as 250-275mm.
9. The fractured surface indicated brownish stain in the upper portion of RCC slab. The reinforcement at the bottom was found to be hanging down. In order to see the top reinforcement, the fractured surface was gently chipped to expose the top bars. The top bars were snapped at the fractured surface. They were found to be positioned at about 100mm (Mid depth) from top of the RCC slab.
10. The left over bars in the fractured region and the snapped bars indicate that the bars are corroded exhibiting brown patches and formation of scales.
11. Wide cracks were observed in the peripheral wall in the third floor of Scary room area of the building.

The photographs 1-30 of Annexure- I. depict the distress regions and observations made above.

After getting few results of the tests, the committee met on Monday, 30.1.2017 and visited the site. It was found that the water pipes which were hanging at the fractured portion got removed and majority of debris were cleared. The cracks observed in the third floor wall behind Scary room were observed to be sealed with cement mortar.

5.0 SAMPLES COLLECTED

In order to assess the quality of materials used in collapsed region, following representative samples were collected:

- Three core of concrete from roof slab near to the fractured portion.
- Steel rods from the fractured part and from debris.
- Concrete sample from the debris of slab.
- Mortar samples from the block masonry parapet wall.
- Water samples from chiller plant

The samples were tested at Civil Aid Techno Clinic Pvt Ltd, Bengaluru as per relevant Indian standards. The details of sampling and testing are shown in Ph31-40 of Annexure-I.

6.0 TESTING

The following tests were conducted on the samples collected from the site:

1. Steel Reinforcement:
 - a. Tensile test
 - b. Bend and Re-bend test
 - c. Chemical Analysis
2. Concrete:
 - a. Compressive strength
 - b. Density
 - c. Cement content
3. Mortar:
 - a. Chemical analysis for proportion
4. Water:
 - a. Chemical Analysis for sulphates and chlorides

The test results are appended in Annexure –II

The following are the observations on test results:

Page 6 of 47

1. The strength of concrete as mentioned in the drawing was 25 MPa, whereas the strength of concrete strength was 15 MPa which is less than design requirement. The density of concrete was found to be 2100 kg/m^3 , which is comparatively less for normal structural concrete.
2. The screed concrete layer provided on the roof slab was 250-275mm thick with a density of 2098 kg/cum.
3. Cement content of concrete was found to be 200 kg/m^3 , which may be considered for mix design, if supplementary cementitious material like fly ash or GGBS is used in the mix. However, the required strength is not achieved, as seen from the core test results.
4. The reinforcement tested confirms to the strength, % elongation, bend and re-bend requirements. The sulphur and phosphorus content in the steel rod was in the range of 0.070 – 0.073 as against maximum value of 0.065 as per IS 1786 - 2008, which may not contribute to the failure.
5. The proportion of masonry mortar obtained from the test is obtained as 1:3 by volume, which is adequate for concrete block masonry parapet.
6. The chemical analysis of chiller water indicates that the water is alkaline in nature and the chlorides and sulphates are within permissible limits.

7.0 REVIEW OF STRUCTURAL DETAILS

The structural drawings pertaining to the collapsed cantilever slab indicate the thickness of slab as 200mm and reinforcement of 12mm @150mm c/c at top and 10mm @150mm c/c at bottom. The concrete strength considered in the design is 25MPa, whereas the in-situ strength of concrete is 15 MPa. As observed at site, in the collapsed region, the top bars are provided at 100mm from top, reducing the effective depth to less than 100mm (Ref Annexure- III). The reinforcement diameter and spacing was found to be as per the drawing. Also, the screed concrete on top has contributed to the superimposed load by 5.25 kN/Sq.m , considering the thickness of 250mm (which appears to be more than the normally adopted

thickness). The calculations for the adequacy of the section, as provided at site, are appended in Annexure-III. The calculations clearly show that the cantilever section, as provided at site is structurally inadequate even for the dead load and superimposed load from the screed.

8.0 INFERENCES

The following are the inferences based on the detailed observations, test results and review of structural details:

1. The tests on materials infer that the in-situ strength of concrete in the tested regions of the roof near to the failure region exhibits lower strength as compared to the strength considered in the design.
2. The failure of cantilever portion of roof slab is essentially due to the structural inadequacy of the section as provided at site. The disposition of top bars to the middle of the section, reduced in – situ concrete strength and increased superimposed load due to undue thickness of screed has made the cantilever section unsafe.
3. The increased thickness of screed provided at site and load due to chiller pipes running in the cantilever portion have added to the overall loading on the roof slab.
4. The calculations imply that the cantilever slab must have undergone excessive deflection and cracking before failure. The bituminous water proofing layer above the slab also, must have cracked. It is likely that the stagnated leakage water from the chiller had seeped into the crack, carrying the brown stain from the waterproofing layer. This could be the reason for occurrence of brown stain on the top portion of the fractured surface at failure location.
5. The failure of cantilever slab in the third floor slab is mainly due to the impact of the falling debris from roof. Further, the cantilever section in third floor also has reduced structural capacity due to disposition of top reinforcement towards the middle of the section, as observed at site.
6. The corrosion of bars in the collapsed region show that the cracks in the slab might have allowed the ingress of water and air into the rc section triggering corrosion.

7. The wall crack in the scary room region is mainly due to deflection of cantilever slab resulting from the loading of 5m height wall at the periphery.
8. The distress observed in the existing cantilever portion of roof slab near the collapsed region is mainly due to the combined effects of collapse of the adjacent slab and structural inadequacy of the cantilever section in carrying the existing loading. This portion of the slab is structurally unsafe.

9.0 RECOMMENDATIONS

1. Since study on the collapse of the portion of the cantilever slab has shown that the slab is structurally unsafe, it is essential to support all the cantilever slabs at all levels through an appropriately designed supporting system to avoid recurrence of similar situation.
2. As the in situ strength of concrete in the tested region of the roof has shown lesser strength than the design requirements and loading on the roof is increased due to screed and other equipment, it is essential to verify the structural adequacy of the entire roof.
3. The cantilever portion in the scary room area shall be suitably supported to withstand the loading due to 5.5 m high peripheral wall. Alternatively, the wall can be replaced with 75mm thick rc wall, if the cantilever section provided can permit the same.

10.0 CONCLUDING REMARKS

Based on the study carried out, it can be concluded that the collapse of a portion of cantilever slab is due to inadequate section (resulting from wrong disposition of top reinforcing bars) of the cantilever at site, leading to formation of crack in the slab and finally collapse of the slab itself. Unduly thick screed concrete on top of the slab and reduced concrete strength have further aided the collapse.

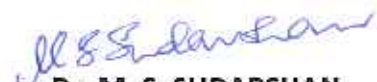
Suitable measures are recommended to render the collapsed region serviceable.

This study is limited to examination of the collapsed region and not the structural stability of the whole building. In view of the present distress and considering the nature of usage of building, the structural stability of the whole building needs to be examined.


Additional Director, Town planning
BBMP
Convener


Commissioner, BBMP
Chairman


Dr. K. S. JAYASIMHA
Member


Dr. M. S. SUDARSHAN
Member


Dr. RADHAKRISHNA
Member


Dr. R. NAGENDRA
Member

ANNEXURE – I

PHOTOGRAPHS



Ph. 01

**General views of the
collapsed region**



Ph. 02



Ph. 03



Ph. 04



Ph. 05

Top view of collapsed cantilever roof slab



Ph. 06

**View of collapsed portion
from third floor**



Ph. 07

**Crack in the cantilever
(Cantilever portion of roof slab
near collapsed region)**



Ph. 08

**Crack in the cantilever
(Cantilever portion of roof slab near collapsed region)**



Ph. 09

Crack in peripheral wall of scary room



Ph. 10

Inspection of cracks



Ph. 11

Measurement of distressed portion



Ph. 12

**Fractured cantilever slab surface with brown stains
(Typical views)**



Ph. 13



Ph. 14

Corroded bottom reinforcement at the fractured surface



Ph. 15

Chipping of fractured surface at roof level to expose top bars



Ph. 16

**Exposed top bars of collapsed cantilever roof slab
(Typical views)**



Ph. 17



Ph. 18

**Snapped top bars of cantilever
(Typical views)**



Ph. 19



Ph. 20

Section at fractured slab with measurement



Ph. 21

View of debris of roof slab showing disposition of top bars



Ph. 22

**Snapped top bar of cantilever
from debris**



Ph. 23

**Corroded snapped top rebar
of cantilever**



**Corroded bars seen
in debris**

Ph. 24

**Disposition of bars in
fractured surface of
cantilever slab of
third floor
(top bars in mid region)**



Ph. 25



**Cracks in cantilever
portion of roof slab**

Ph. 26



Ph. 27

View of deflected cantilever slab beyond the collapsed slab



Ph. 28

Patched up cracks in the wall of scary room



Ph. 29

Cracks in RCC parapet wall



Ph. 30

**View of debris
(partly cleared)**



Ph. 31

**Collection of bottom reinforcement of
cantilever slab for testing**



Ph. 32

**Top bars of collapsed cantilever roof slab
collected from debris**



Ph. 33

Extraction of concrete core sample from RC slab in progress



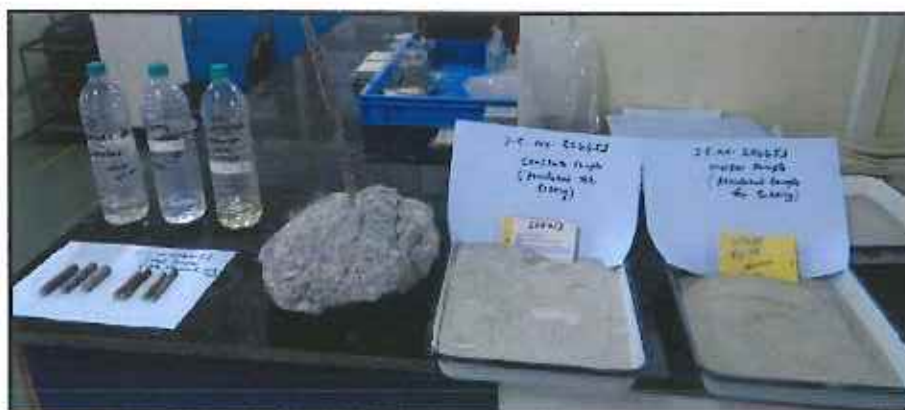
Ph. 34

View of extracted concrete core samples from screed and slab



Ph. 35

Core from screed



Ph. 36

Samples for testing



Ph. 37

**Views of core compressive strength
test in progress**



Ph. 38



Ph. 39

Tensile testing of reinforcing steel



Ph. 40

Bend and Rebend test

ANNEXURE – II

TEST RESULTS



CIVIL-AID



Ref: CIVIL AID: STEEL/BI/2025/1/2017

Date: 31.1.2017

Test Order dated: 24.1.2017

The Commissioner
Bruhat Bangalore Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

PHYSICAL TEST REPORT ON REINFORCING STEEL

Source of sample : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
UIN : 17002187
Date of test : 25.1.2017
Project* : Spot Inspection on Quality of Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Grade* : Not furnished
Condition of samples : Satisfactory
Test Method : IS: 1608 - 2005 (Reaffirmed 2011), IS: 1599 - 2012 and IS: 1786-2008 (Reaffirmed 2013)

Sl No	Identification	Nominal Dia* (mm)	Mass (Wt.) (kg/m)	Tensile Test			Bend Test	Rebend Test
				0.2% Proof Stress / Yield Stress (N/mm ²)	Ultimate Tensile Strength (N/mm ²)	Elongation (%)		
1	Bottom Bar	10	0.567	615	727	16.0	Passes	Passes
2	Top Bar	12	0.895	525	624	21.7	Passes	Passes

Requirements as per IS: 1786 - 2008

Dia (mm)	Mass (wt.) (kg/m) (Min.)	Dia (mm)	Mass (wt.) (kg/m) (Min.)	Grade	0.2% Proof Stress / Yield Stress (N/mm ²) (Min.)	Ultimate Tensile Strength (N/mm ²) (Min.)	Elongation (%) (Min.)
8	0.363	20	2.366	Fe-415	415	485 or 10% more than Actual Proof Stress whichever is higher	14.5
10	0.567	25	3.697	Fe-500	500	545 or 8% more than Actual Proof Stress whichever is higher	12.0
12	0.834	28	4.638			565 or 10% more than Actual Proof Stress whichever is higher	
16	1.483	32	6.058	Fe-500D	500	565 or 10% more than Actual Proof Stress whichever is higher	16.0
		40	9.465			565 or 10% more than Actual Proof Stress whichever is higher	

* As furnished by the customer

Note: 1. The results relate only to the samples tested.
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for CIVIL AID TECHNOCLINIC PVT. LTD.,

SANJEEV PATGAR
Quality Manager

302557

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**CIVIL-AID**

Ref: CIVIL AID: STEEL/BL/2025(a)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
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 Commissioner Office
 N.R. Square
 Bangalore - 2

CHEMICAL TEST REPORT ON REINFORCING STEEL

Source of sample : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002187
 Date of test : 25.1.2017
 Project* : Spot Inspection on Quality of Commercial Building at
 Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige
 Road, Malleswaram, Bangalore
 Grade* : Not furnished
 Condition of samples : Satisfactory
 Test Method : IS:8811 - 1998 (Reaffirmed 2012)

Sl No	Identification	Nominal Dia* (mm)	Carbon (%)	Phosphorus (%)	Sulphur (%)	Sulphur + Phosphorus
1	Bottom Bar	10	0.186	0.074	0.070	0.144
2		10	0.197	0.074	0.071	0.145
3	Top Bar	12	0.200	0.075	0.071	0.146
4		12	0.207	0.075	0.073	0.148

Requirements as per IS:1786-2008 (% Max) with tolerance			
Grade	Fe-415	Fe-500	Fe-500D
Carbon (C)	0.320	0.320	0.270
Phosphorus (P)	0.065	0.060	0.045
Sulphur (S)	0.065	0.060	0.045
S + P	0.120	0.115	0.085

* As furnished by the customer.

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for **CIVIL-AID TECHNOCLINIC PVT. LTD.**

Signature
 31/1/17

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Date : 31.1.2017

Ref: CIVIL-AID/CC/BL/2025/1/2017
Test order dated : 24.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square, Bangalore - 2

TEST REPORT ON CONCRETE CORE SAMPLES

Sample collected by Expert Technical Team Members

3 (Three)

17002191

Letter dated 16.1.17

Spot Inspection on Quality of Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore

Not furnished

More than 28 days

28.1.17

Civil-Aid Technoclinic Pvt. Ltd.

Epoxy

Satisfactory

IS:516-1959 (Reaffirmed in 2013) and IS:456-2000 (Reaffirmed 2011)

Sl. No.	Identification	Length (H) (mm)**	Dia (D) (mm)	Wt. (g)**	Failure Load (kN)	Core Comp. Strength (N/mm ²)	H/D Ratio	Correction factor for (H/D) ratio+	Corrected Cyl. Comp Strength (N/mm ²)	Equivalent Cube Comp. Strength++ (N/mm ²)	Type of Failure
1	Sample - 1	111	92	1.557	74.8	12.15	1.207	0.914	11.10	13.9	Typical Compressive failure
2	Sample - 2	127	91	1.756	66.66	11.06	1.396	0.934	10.34	12.9	
3	Sample - 3	133	92	1.962	79.10	12.85	1.446	0.940	12.07	15.1	

** Core Length and core weight after trimming and capping

After applying correction factor for diameter of core which is less than 100 mm (i.e. strength of core x 1.08) as per SP:24-1982, Clause: 16.3.2).

- For H/D ratio, correction factors are as per Figure-1 of IS:516-1959 (Reaffirmed in 2013).

++ Equivalent cube compressive strength = 1.25 x corrected cylinder compressive strength as per clause 5.6.1 of IS:516-1959 (Reaffirmed in 2008).

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for CIVIL-AID-TECHNOCLINIC PVT. LTD.



[Signature]
31/01/2017

SANJEEV PATGAR
Quality Manager



CIVIL-AID

Ref: CIVIL AID: SPL: BL/2025/1/2017
Test Order dated: 24.1.17

Date: 31.1.2017

The Commissioner
Bruhat Bangalore Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON CONCRETE CORE SAMPLE [SCREED]

Source of sample : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
UTN : 17002187
Project* : Spot Inspection on Quality of Commercial Building at
Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road,
Malleswaram, Bangalore
Date of Test : 27.1.17
Condition of sample : Satisfactory
Test Method : Laboratory Developed Method

Sl. No.	Dia of the core (mm)	Height of the core (mm)	Density (kg/m ³)
1	142	249	2098

* As furnished by the customer

Note: 1. The results relate only to the items tested.
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for CIVIL AID TECHNOCLINIC PVT. LTD.

302555

31/01/2017
SANJEEV PATGAR
Quality Manager



CIVIL-AID

Ref: CIVIL AID: IIC: BL/2025/1/2017
Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON HARDENED CONCRETE SAMPLE

Source of sample	:	Sample collected by Expert Technical Team Members
No. of samples tested	:	1 (One)
UIN	:	17002188
Customer's Reference	:	Letter No. IINNP/PR/1341/2016-17 dated 17.1.2017
Project*	:	Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Period of test	:	25.1.2017 to 30.1.2017
Condition of sample	:	Satisfactory
Technical Reference	:	ASTM : C 1324-2005 and ASTM : C 1084-10 and IS 4032 - 1985 (Reaffirmed 2009)

TEST RESULTS:

Sl. No.	Identification	Cement Content	
		(% by Mass)	(kg/Cu.m)#
1	Concrete sample collected from Embedded Steel	9.41	203.0

* As furnished by the customer.

Cement content is calculated by taking density of hardened concrete of 2152 kg/cu.m.
The density was calculated in the concrete core samples collected from the site.

Remarks:

1. The above calculation of cement content is based on the assumption that CaO content in Ordinary Portland Cement used for the concrete contains 63.50 percent by mass.
2. In the absence of original ingredients of concrete used, estimated cement content may be in error by 10 to 20 percent from the actual cement used.
3. The above test results are strictly applicable for the tested sample of concrete made out of 100% Ordinary Portland Cement only.

Note:

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for CIVIL-AID TECHNOCLINIC Pvt. Ltd.

[Signature]
31/01/2017

DINESH H.T.
Manager - Lab



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Ref:CIVIL-AID:HC: BL/2025/1/2017
Test Order dated: 24.1.2017

CIVIL-AID

Date: 31.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON HARDENED MORTAR SAMPLE

Source of sample : Sample collected by Expert Technical Team Members
No. of samples tested : 1 (One)
UIN : 17002188
Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Period of test : 25.1.2017 to 30.1.2017
Condition of sample : Satisfactory
Technical Reference : ASTM : C 1324-2005 and ASTM : C 1084-10 and IS 4032 - 1985 (Reaffirmed 2009)

TEST RESULTS:

Sl. No.	Identification	Cement Content		Estimated proportion of cement : sand (by volume)
		(% by Mass)	(kg/Cu.m)#	
1	--	23.65	492.00	1 : 3.10

* As furnished by the customer.

Cement content is calculated based on density of hardened mortar of 2080 kg/cu.m as per IS:875 (Part 1)-1987 (Reaffirmed in 2008)

Remarks: 1. The above calculation of cement content is based on the assumption that CaO content in Ordinary Portland Cement used for the mortar contains 63.50 percent by mass.
2. In the absence of original ingredients of mortar used, estimated cement content may be in error by 10 to 20 percent from the actual cement used.
3. The above test results are strictly applicable for the tested sample of mortar made out of 100% Ordinary Portland Cement only.

Note: 1. The results relate only to the items tested.
2. Report shall not be reproduced, except in full, without written approval of the laboratory.
3. Any correction invalidates this report

for **CIVIL-AID TECHNOCLINIC Pvt. Ltd.**

DINESH H.T.
Manager - Lab



Page 37 of 47

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**CIVIL-AID**

Ref: CIVIL AID: WATER/BL/2025(a)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
 Bruhat Bengaluru Mahanagara Palike
 Commissioner Office
 N.R. Square
 Bangalore – 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002189
 Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
 Sample Identification / Location of sample collected * : From Circular
 Sample collected on : 21.1.2017 @ 4.00 p.m.
 Condition of sample : Satisfactory
 Period of test : 25.1.2017 to 30.1.2017
 Test Method : IS:456 – 2000 (Reaffirmed 2011)
 IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	402.78 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₃	254.99 mg/l	400 mg/l max.
3	pH Value	9.00	Shall not be less than 6

* As furnished by the customer

Note: 1. The results relate only to the items tested.
 2. Report shall not be reproduced, except in full, without the written approval of the lab.
 3. Any correction invalidates this report.

for **CIVIL AID TECHNOCLINIC PVT. LTD.**



DINESH H.T.
 Manager - Lab



Ref: CIVIL AID: WATER/BL/2025(b)/1/2017
Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. IINNP/PR/1341/2016-17 dated 17.1.2017
UIN : 17002189
Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Sample Identification / Location of sample collected* : From Raw Water
Sample collected on : 21.1.2017 @ 4.00 p.m.
Condition of sample : Satisfactory
Period of test : 25.1.2017 to 30.1.2017
Test Method : IS:456 - 2000 (Reaffirmed 2011)
IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	82.26 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₂	11.84 mg/l	400 mg/l max.
3	pH Value	7.30	Shall not be less than 6

* As furnished by the customer.

- Note: 1. The results relate only to the items tested.
2. Report shall not be reproduced, except in full, without the written approval of the lab.
3. Any correction invalidates this report.

for **CIVIL AID TECHNOCLINIC PVT. LTD.**



Dinesh H.T.
31/01/2017

DINESH H.T.
Manager - Lab

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**CIVIL-AID**

Ref: CIVIL-AID:WATER/BL/2025(c)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
 Bruhat Bengaluru Mahanagara Palike
 Commissioner Office
 N.R. Square
 Bangalore – 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002189
 Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
 Sample Identification / Location of sample collected * : From Softner Plant
 Sample collected on : 21.1.2017 @ 4.00 p.m.
 Condition of sample : Satisfactory
 Period of test : 25.1.2017 to 30.1.2017
 Test Method : IS:456 – 2000 (Reaffirmed 2011)
 IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	90.77 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₃	9.61 mg/l	400 mg/l max.
3	pH Value	7.33	Shall not be less than 6

* As furnished by the customer

Note: 1. The results relate only to the items tested.
 2. Report shall not be reproduced, except in full, without the written approval of the lab.
 3. Any correction invalidates this report.

for **CIVIL AID TECHNOCLINIC PVT. LTD.**



D. H. H.
 31/01/2017
DINESH H.T.
 Manager - Lab

ANNEXURE – III

CALCULATION & SKETCH

CALCULATIONS FOR STRUCTURAL ADEQUACY OF CANTILEVER SLAB

Effective depth as at site = 200-100-12/2 = 94 mm

Area of steel provided per meter of width
of slab (12 mm @150 c/c) = $\frac{1000 \times 113}{150} = 753.3 \text{ mm}^2$

Moment of resistance of section M_u = $0.87 f_y \times A_{st} d \left(1 - \frac{A_{st} \times f_y}{bd \times f_{ck}}\right)$

Grade of steel - Fe 415

Grade of concrete - M15 (as obtained from results of
core test)

$M_u = 0.87 \times 415 \times 753.33 \left(1 - \frac{753.33 \times 415}{1000 \times 94 \times 15}\right)$

$M_u = 19.9 \times 10^6 \text{ N-mm}$
= 19.9 kN-m

Theoretical Verification of the design:

The loadings on the slab

Self Weight of the slab (thickness of the slab) = 0.2 x 25 = 5.0 kN/m²

Weight of screed of concrete
(250 mm thick as measured at site) = 0.25 x 21*
(*density as determined from the core extracted from screed) 5.25 kN/m²

Total uniform dead load 10.25 kN/m²

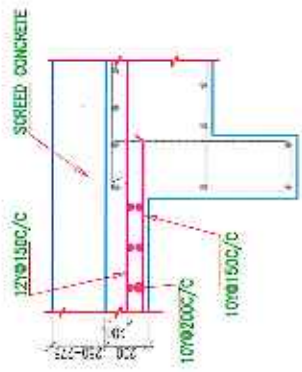
Point load at the tip due to r c parapet wall of height 1.3 m and 200 mm thick
 $0.2 \times 1.3 \times 2.5 = 6.5 \text{ kN}$

Unfactored bending moment = $10.25 \times 2^2/2 + 6.5 \times 2$
= 33.5 kN-m

Factored bending moment $= 33.5 \times 1.5 = 50.25 \text{ kNm}$

Moment of resistance of the section as exist at site = 19.9kN-m which is less than the Actual moment.

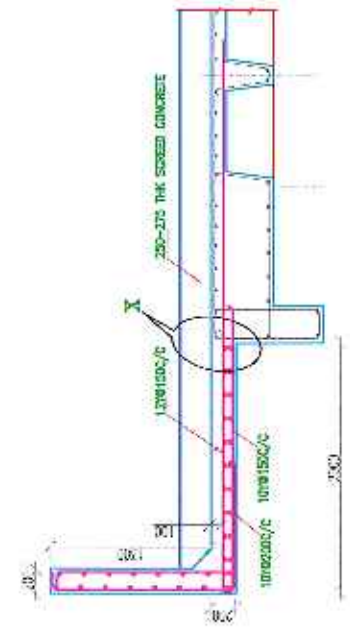
From the above, it is clear that the existing section is not capable of withstanding its own self weight along with the screed and parapet wall (without considering any live load on the roof)



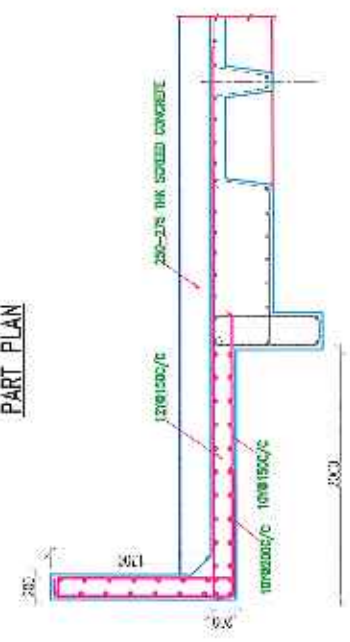
DETAIL AT X
EXISTING

PART PLAN

NOTE : ALL DIMENSIONS IN MM



SECTION -1
EXISTING



SECTION -1
AS PER STANDARD PRACTICE

FIGURE-1



2. ಡಾ|| ಕೆ.ಎಸ್. ಜಯಸಿಂಹ, ಮುಖ್ಯಸ್ಥರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.
3. ಡಾ|| ಆರ್.ನಾಗೇಂದ್ರ, ತಾಂತ್ರಿಕ ನಿರ್ದೇಶಕರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.
4. ಡಾ|| ಎಮ್.ಎಸ್.ಸುದರ್ಶನ್, ಸೀನಿಯರ್ ನಿರ್ದೇಶಕರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.

ಪ್ರತಿಯನ್ನು:

1. ಪೂಜ್ಯ ಮಹಾಪೌರರ ರವರ ಅವಗಾಹನೆಗೆ ತರಲು ಆಪ್ತ ಶಾಖೆಗೆ ಕಳುಹಿಸಿದೆ.
2. ಮಾನ್ಯ ಉಪ ಮಹಾಪೌರರು ರವರ ಅವಗಾಹನೆಗೆ ತರಲು ಆಪ್ತ ಶಾಖೆಗೆ ಕಳುಹಿಸಿದೆ.
3. ವಿಶೇಷ ಆಯುಕ್ತರು (ಯೋಜನೆಗಳು) ರವರ ಮಾಹಿತಿಗಾಗಿ.
4. ಪ್ರಧಾನ ಅಭಿಯಂತರರು, ರವರ ಮಾಹಿತಿಗಾಗಿ.
5. ಅಪರ ಆಯುಕ್ತರು (ಆಡಳಿತ) ರವರ ಮಾಹಿತಿಗಾಗಿ
6. ಅಪರ ಆಯುಕ್ತರು / ಜಂಟಿ ಆಯುಕ್ತರು (ಪಶ್ಚಿಮ ವಲಯ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
7. ಅಪರ ನಿರ್ದೇಶಕರು (ನಗರ ಯೋಜನೆ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
8. ಮುಖ್ಯ ಅಭಿಯಂತರರು (ಪಶ್ಚಿಮ ವಲಯ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
9. ಮುಖ್ಯ ಲೆಕ್ಕ ಪರಿಶೋಧಕರವರಿಗೆ ಕಳುಹಿಸುತ್ತಾ ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯ ಸದಸ್ಯರಿಗೆ ತಗಲುವ ವೆಚ್ಚವನ್ನು ಭರಿಸಲು ಸೂಚಿಸಿದೆ.
10. ಜಂಟಿ ನಿರ್ದೇಶಕರು (ನಗರ ಯೋಜನೆ - ದಕ್ಷಿಣ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
11. ಕಾನೂನು ಕೋಶದ ಮುಖ್ಯಸ್ಥರು, ಬಿಜಿಎಂಪಿ ರವರ ಮಾಹಿತಿಗಾಗಿ ಕಳುಹಿಸಲಾಗಿದೆ.
12. ಕಛೇರಿ ಪ್ರತಿ

o/c

**EXPERT COMMITTEE REPORT ON COLLAPSE OF
CANTILEVER PORTION OF COMMERCIAL BUILDING
AT SAMPIGE ROAD, MALLESWARAM,
BENGALURU**

2ND FEBRUARY 2017

Report for

**The Commissioner
Bruhat Bengaluru Mahanagara Palike
Bengaluru**

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1.0 PREAMBLE

The commercial building -Mantri mall, is a conventional RC framed structure with two basements, ground and three upper floors. The building is reported to be built during 2006-2008 and is in operation since 2008. It was reported that part of this commercial building (Mantri square mall) located at Malleshwaram, Bengaluru was collapsed at about 1.30 PM on Monday, 16th Jan 2017. In view of this, an expert committee was constituted by Commissioner, BBMP to investigate the causes of failure and to suggest suitable remedial measures wide ref no. Heniniyo/PR/ 1341/2016-17 dated: 17-01-2017 (Annexure-IV). The team carried out the study consisting of detailed physical examination, collection of samples, testing and review of structural drawings. Based on the study, the inferences and recommendations were made. This report gives details of the study carried out.

The scope of this study is limited to examination of the collapsed region of the structure, review of structural details of the collapsed region, arriving at reasons for collapse and recommending strengthening measures. In view of constraints of time and resources the study is limited only to collapsed region.

2.0 TEAM

The members of the committee are as follows.

1. Commissioner, BBMP, Chairman
2. Additional Director (Urban), Convener
3. Dr. Radhakrishna, Associate professor, R V College of Engineering, Member
4. Dr. K S Jayasimha, Head, Civil Aid Techno clinic Pvt Ltd, Member
5. Dr. R. Nagendra, Technical Director, Civil Aid Techno clinic Pvt Ltd, Member
6. Dr. M.S. Sudarshan, Senior Director, Civil Aid Techno clinic Pvt Ltd, Member.

The committee had its first meeting at office of BBMP (West), Malleshwaram on Wednesday, 18th Jan 2017. Later the committee visited the site and had preliminary inspection. The fractured portion was inspected from roof, intermediate floors and ground level. It was found that cantilever portions of the slab were collapsed from roof and III floor

(ph 1-6 of Annexure-1). Since it was not possible to closely inspect the fractured part, the inspection committee requested for providing a suitable platform/scaffolding. Other facilities such as videography, photography, relevant structural drawings, provision for core cutting with accessories etc. were also requested to carry out detailed inspection.

After providing the platform and other facilities the committee visited the site on Saturday, 21st Jan 2017 for a detailed inspection and sample collection.

3.0 DATES OF INSPECTION

The team inspected the site for inspection and collection of samples on the following dates:

1. Wednesday, 18.1.2017
2. Saturday, 21.1.2017
3. Monday, 23.1.2017
4. Monday, 30.1.2017

4.0 OBSERVATIONS

The following observations were made during the inspection:

1. The cantilever slabs of span 2 m are provided in the second, third and roof slab levels at the rear portion of the building. They intend to serve as fire exit pathway and access to services.
2. The collapse of a portion of cantilever roof slab and a portion of second floor balcony slab had occurred at the northwest corner of Mantri Mali Building.
3. The debris had fallen on ground at rear region of the building. Some portions of the slab, along with service cables were hanging in the collapsed region.
4. In the cantilever portion of the roof, two chiller pipes of 600mm diameter are placed on regular pedestal, carrying water.
5. In the northwest region, cantilever roof slab to a length of about 17 m had collapsed, along with the R.C. parapet. The collapse had created distress in the form of cracks in the remaining cantilever slab to a length of about 8m. These cracks were along the cantilever support.

6. Cracks were also observed in the RCC parapet wall which is existing near to the collapsed region.
7. It appears that the failure is first triggered in the roof and the debris fell on the third floor cantilever slab. This gave way due to the impact of the falling debris. However, the second floor cantilever slab suffered only the damage to the parapet and no visible distress was observed in the cantilever slab region.
8. The fractured section of the cantilevered roof slab shows the top layer of membrane waterproofing followed by screed concrete layer. A bituminous water proof layer was seen between the screed and RCC slab. The thickness of RCC slab was measured as 200mm and the thickness of screed concrete was measured as 250-275mm.
9. The fractured surface indicated brownish stain in the upper portion of RCC slab. The reinforcement at the bottom was found to be hanging down. In order to see the top reinforcement, the fractured surface was gently chipped to expose the top bars. The top bars were snapped at the fractured surface. They were found to be positioned at about 100mm (Mid depth) from top of the RCC slab.
10. The left over bars in the fractured region and the snapped bars indicate that the bars are corroded exhibiting brown patches and formation of scales.
11. Wide cracks were observed in the peripheral wall in the third floor of Scary room area of the building.

The photographs 1-30 of Annexure- I. depict the distress regions and observations made above.

After getting few results of the tests, the committee met on Monday, 30.1.2017 and visited the site. It was found that the water pipes which were hanging at the fractured portion got removed and majority of debris were cleared. The cracks observed in the third floor wall behind Scary room were observed to be sealed with cement mortar.

5.0 SAMPLES COLLECTED

In order to assess the quality of materials used in collapsed region, following representative samples were collected:

- Three core of concrete from roof slab near to the fractured portion.
- Steel rods from the fractured part and from debris.
- Concrete sample from the debris of slab.
- Mortar samples from the block masonry parapet wall.
- Water samples from chiller plant

The samples were tested at Civil Aid Techno Clinic Pvt Ltd, Bengaluru as per relevant Indian standards. The details of sampling and testing are shown in Ph31-40 of Annexure-I.

6.0 TESTING

The following tests were conducted on the samples collected from the site:

1. Steel Reinforcement:
 - a. Tensile test
 - b. Bend and Re-bend test
 - c. Chemical Analysis
2. Concrete:
 - a. Compressive strength
 - b. Density
 - c. Cement content
3. Mortar:
 - a. Chemical analysis for proportion
4. Water:
 - a. Chemical Analysis for sulphates and chlorides

The test results are appended in Annexure –II

The following are the observations on test results:

Page 6 of 47

1. The strength of concrete as mentioned in the drawing was 25 MPa, whereas the strength of concrete strength was 15 MPa which is less than design requirement. The density of concrete was found to be 2100 kg/m^3 , which is comparatively less for normal structural concrete.
2. The screed concrete layer provided on the roof slab was 250-275mm thick with a density of 2098 kg/cum.
3. Cement content of concrete was found to be 200 kg/m^3 , which may be considered for mix design, if supplementary cementitious material like fly ash or GGBS is used in the mix. However, the required strength is not achieved, as seen from the core test results.
4. The reinforcement tested confirms to the strength, % elongation, bend and re-bend requirements. The sulphur and phosphorus content in the steel rod was in the range of 0.070 – 0.073 as against maximum value of 0.065 as per IS 1786 - 2008, which may not contribute to the failure.
5. The proportion of masonry mortar obtained from the test is obtained as 1:3 by volume, which is adequate for concrete block masonry parapet.
6. The chemical analysis of chiller water indicates that the water is alkaline in nature and the chlorides and sulphates are within permissible limits.

7.0 REVIEW OF STRUCTURAL DETAILS

The structural drawings pertaining to the collapsed cantilever slab indicate the thickness of slab as 200mm and reinforcement of 12mm @150mm c/c at top and 10mm @150mm c/c at bottom. The concrete strength considered in the design is 25MPa, whereas the in-situ strength of concrete is 15 MPa. As observed at site, in the collapsed region, the top bars are provided at 100mm from top, reducing the effective depth to less than 100mm (Ref Annexure- III). The reinforcement diameter and spacing was found to be as per the drawing. Also, the screed concrete on top has contributed to the superimposed load by 5.25 kN/Sq.m , considering the thickness of 250mm (which appears to be more than the normally adopted

thickness). The calculations for the adequacy of the section, as provided at site, are appended in Annexure-III. The calculations clearly show that the cantilever section, as provided at site is structurally inadequate even for the dead load and superimposed load from the screed.

8.0 INFERENCES

The following are the inferences based on the detailed observations, test results and review of structural details:

1. The tests on materials infer that the in-situ strength of concrete in the tested regions of the roof near to the failure region exhibits lower strength as compared to the strength considered in the design.
2. The failure of cantilever portion of roof slab is essentially due to the structural inadequacy of the section as provided at site. The disposition of top bars to the middle of the section, reduced in – situ concrete strength and increased superimposed load due to undue thickness of screed has made the cantilever section unsafe.
3. The increased thickness of screed provided at site and load due to chiller pipes running in the cantilever portion have added to the overall loading on the roof slab.
4. The calculations imply that the cantilever slab must have undergone excessive deflection and cracking before failure. The bituminous water proofing layer above the slab also, must have cracked. It is likely that the stagnated leakage water from the chiller had seeped into the crack, carrying the brown stain from the waterproofing layer. This could be the reason for occurrence of brown stain on the top portion of the fractured surface at failure location.
5. The failure of cantilever slab in the third floor slab is mainly due to the impact of the falling debris from roof. Further, the cantilever section in third floor also has reduced structural capacity due to disposition of top reinforcement towards the middle of the section, as observed at site.
6. The corrosion of bars in the collapsed region show that the cracks in the slab might have allowed the ingress of water and air into the rc section triggering corrosion.

7. The wall crack in the scary room region is mainly due to deflection of cantilever slab resulting from the loading of 5m height wall at the periphery.
8. The distress observed in the existing cantilever portion of roof slab near the collapsed region is mainly due to the combined effects of collapse of the adjacent slab and structural inadequacy of the cantilever section in carrying the existing loading. This portion of the slab is structurally unsafe.

9.0 RECOMMENDATIONS

1. Since study on the collapse of the portion of the cantilever slab has shown that the slab is structurally unsafe, it is essential to support all the cantilever slabs at all levels through an appropriately designed supporting system to avoid recurrence of similar situation.
2. As the in situ strength of concrete in the tested region of the roof has shown lesser strength than the design requirements and loading on the roof is increased due to screed and other equipment, it is essential to verify the structural adequacy of the entire roof.
3. The cantilever portion in the scary room area shall be suitably supported to withstand the loading due to 5.5 m high peripheral wall. Alternatively, the wall can be replaced with 75mm thick rc wall, if the cantilever section provided can permit the same.

10.0 CONCLUDING REMARKS

Based on the study carried out, it can be concluded that the collapse of a portion of cantilever slab is due to inadequate section (resulting from wrong disposition of top reinforcing bars) of the cantilever at site, leading to formation of crack in the slab and finally collapse of the slab itself. Unduly thick screed concrete on top of the slab and reduced concrete strength have further aided the collapse.

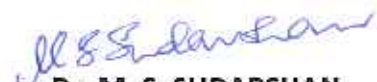
Suitable measures are recommended to render the collapsed region serviceable.

This study is limited to examination of the collapsed region and not the structural stability of the whole building. In view of the present distress and considering the nature of usage of building, the structural stability of the whole building needs to be examined.


Additional Director, Town planning
BBMP
Convener


Commissioner, BBMP
Chairman


Dr. K. S. JAYASIMHA
Member


Dr. M. S. SUDARSHAN
Member


Dr. RADHAKRISHNA
Member


Dr. R. NAGENDRA
Member

ANNEXURE – I

PHOTOGRAPHS



Ph. 01

**General views of the
collapsed region**



Ph. 02



Ph. 03



Ph. 04



Ph. 05

Top view of collapsed cantilever roof slab



Ph. 06

**View of collapsed portion
from third floor**



Ph. 07

**Crack in the cantilever
(Cantilever portion of roof slab
near collapsed region)**



Ph. 08

**Crack in the cantilever
(Cantilever portion of roof slab near collapsed region)**



Ph. 09

Crack in peripheral wall of scary room



Ph. 10

Inspection of cracks



Ph. 11

Measurement of distressed portion



Ph. 12

**Fractured cantilever slab surface with brown stains
(Typical views)**



Ph. 13



Ph. 14

Corroded bottom reinforcement at the fractured surface



Ph. 15

Chipping of fractured surface at roof level to expose top bars



Ph. 16

**Exposed top bars of collapsed cantilever roof slab
(Typical views)**



Ph. 17



Ph. 18

**Snapped top bars of cantilever
(Typical views)**



Ph. 19



Ph. 20

Section at fractured slab with measurement



Ph. 21

View of debris of roof slab showing disposition of top bars



Ph. 22

**Snapped top bar of cantilever
from debris**



Ph. 23

**Corroded snapped top rebar
of cantilever**



**Corroded bars seen
in debris**

Ph. 24

**Disposition of bars in
fractured surface of
cantilever slab of
third floor
(top bars in mid region)**



Ph. 25



**Cracks in cantilever
portion of roof slab**

Ph. 26



Ph. 27

View of deflected cantilever slab beyond the collapsed slab



Ph. 28

Patched up cracks in the wall of scary room



Ph. 29

Cracks in RCC parapet wall



Ph. 30

**View of debris
(partly cleared)**



Ph. 31

**Collection of bottom reinforcement of
cantilever slab for testing**



Ph. 32

**Top bars of collapsed cantilever roof slab
collected from debris**



Ph. 33

Extraction of concrete core sample from RC slab in progress



Ph. 34

View of extracted concrete core samples from screed and slab



Ph. 35

Core from screed



Ph. 36

Samples for testing



Ph. 37

**Views of core compressive strength
test in progress**



Ph. 38



Ph. 39

Tensile testing of reinforcing steel



Ph. 40

Bend and Rebend test

ANNEXURE – II

TEST RESULTS



CIVIL-AID



Ref: CIVIL AID: STEEL/BI/2025/1/2017

Date: 31.1.2017

Test Order dated: 24.1.2017

The Commissioner
Bruhat Bangalore Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

PHYSICAL TEST REPORT ON REINFORCING STEEL

Source of sample : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
UIN : 17002187
Date of test : 25.1.2017
Project* : Spot Inspection on Quality of Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Grade* : Not furnished
Condition of samples : Satisfactory
Test Method : IS: 1608 - 2005 (Reaffirmed 2011), IS: 1599 - 2012 and IS: 1786-2008 (Reaffirmed 2013)

Sl No	Identification	Nominal Dia* (mm)	Mass (Wt.) (kg/m)	Tensile Test			Bend Test	Rebend Test
				0.2% Proof Stress / Yield Stress (N/mm ²)	Ultimate Tensile Strength (N/mm ²)	Elongation (%)		
1	Bottom Bar	10	0.567	615	727	16.0	Passes	Passes
2	Top Bar	12	0.895	525	624	21.7	Passes	Passes

Requirements as per IS: 1786 - 2008

Dia (mm)	Mass (wt.) (kg/m) (Min.)	Dia (mm)	Mass (wt.) (kg/m) (Min.)	Grade	0.2% Proof Stress / Yield Stress (N/mm ²) (Min.)	Ultimate Tensile Strength (N/mm ²) (Min.)	Elongation (%) (Min.)
8	0.363	20	2.366	Fe-415	415	485 or 10% more than Actual Proof Stress whichever is higher	14.5
10	0.567	25	3.697	Fe-500	500	545 or 8% more than Actual Proof Stress whichever is higher	12.0
12	0.834	28	4.638			565 or 10% more than Actual Proof Stress whichever is higher	
16	1.483	32	6.058	Fe-500D	500	565 or 10% more than Actual Proof Stress whichever is higher	16.0
		40	9.465			565 or 10% more than Actual Proof Stress whichever is higher	

* As furnished by the customer

Note: 1. The results relate only to the samples tested.
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for CIVIL AID TECHNOCLINIC PVT. LTD.,

SANJEEV PATGAR
Quality Manager

302557

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**CIVIL-AID**

Ref: CIVIL-AID:STEEI/BL/2025(a)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
 Bruhat Bangalore Mahanagara Palike
 Commissioner Office
 N.R. Square
 Bangalore - 2

CHEMICAL TEST REPORT ON REINFORCING STEEL

Source of sample : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002187
 Date of test : 25.1.2017
 Project* : Spot Inspection on Quality of Commercial Building at
 Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige
 Road, Malleswaram, Bangalore
 Grade* : Not furnished
 Condition of samples : Satisfactory
 Test Method : IS:8811 - 1998 (Reaffirmed 2012)

Sl No	Identification	Nominal Dia* (mm)	Carbon (%)	Phosphorus (%)	Sulphur (%)	Sulphur + Phosphorus
1	Bottom Bar	10	0.186	0.074	0.070	0.144
2		10	0.197	0.074	0.071	0.145
3	Top Bar	12	0.200	0.075	0.071	0.146
4		12	0.207	0.075	0.073	0.148

Requirements as per IS:1786-2008 (% Max) with tolerance			
Grade	Fe-415	Fe-500	Fe-500D
Carbon (C)	0.320	0.320	0.270
Phosphorus (P)	0.065	0.060	0.045
Sulphur (S)	0.065	0.060	0.045
S + P	0.120	0.115	0.085

* As furnished by the customer.

- Note:
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for **CIVIL-AID TECHNOCLINIC PVT. LTD.**



Signature
 31/1/17

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Date : 31.1.2017

Ref: CIVIL-AID/CC/BL/2025/1/2017
Test order dated : 24.1.2017

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N.R. Square, Bangalore - 2

TEST REPORT ON CONCRETE CORE SAMPLES

Sample collected by Expert Technical Team Members

No. of sample tested : 3 (Three)

UTN : 17002191

Customer reference : Letter dated 16.1.17

Project* : Spot Inspection on Quality of Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore

Grade of concrete * : Not furnished

Age of concrete : More than 28 days

Date of test : 28.1.17

Trimming & capping done by : Civil-Aid Technoclinic Pvt. Ltd.

Capping material used : Epoxy

Condition of samples : Satisfactory

Technical Reference : IS-516-1959 (Reaffirmed in 2013) and IS-456-2000 (Reaffirmed 2011)

Sl. No.	Identification	Length (H) (mm)**	Dia (D) (mm)	Wt. (g)**	Failure Load (kN)	Core Comp. Strength (N/mm ²)	H/D Ratio	Correction factor for (H/D) ratio+	Corrected Cyl. Comp Strength (N/mm ²)	Equivalent Cube Comp. Strength++ (N/mm ²)	Type of Failure
1	Sample - 1	111	92	1.557	74.8	12.15	1.207	0.914	11.10	13.9	Typical Compressive failure
2	Sample - 2	127	91	1.756	66.66	11.06	1.396	0.934	10.34	12.9	
3	Sample - 3	133	92	1.962	79.10	12.85	1.446	0.940	12.07	15.1	

** Core Length and core weight after trimming and capping

After applying correction factor for diameter of core which is less than 100 mm (i.e. strength of core x 1.08) as per SP-24-1982, Clause: 16.3.2).

- For H/D ratio, correction factors are as per Figure-1 of IS-516-1959 (Reaffirmed in 2013).

++ Equivalent cube compressive strength = 1.25 x corrected cylinder compressive strength as per clause 5.6.1 of IS-516-1959 (Reaffirmed in 2008).

Note: 1. The results relate only to the items tested.

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for CIVIL-AID-TECHNOCLINIC PVT. LTD.



[Signature]
31/01/2017

SANJEEV PATGAR
Quality Manager



CIVIL-AID

Ref: CIVIL AID: SPL: BL/2025/1/2017
Test Order dated: 24.1.17

Date: 31.1.2017

The Commissioner
Bruhat Bangalore Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON CONCRETE CORE SAMPLE [SCREED]

Source of sample : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
UTN : 17002187
Project* : Spot Inspection on Quality of Commercial Building at
Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road,
Malleswaram, Bangalore
Date of Test : 27.1.17
Condition of sample : Satisfactory
Test Method : Laboratory Developed Method

Sl. No.	Dia of the core (mm)	Height of the core (mm)	Density (kg/m ³)
1	142	249	2098

* As furnished by the customer

Note: 1. The results relate only to the items tested.
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for CIVIL AID TECHNOCLINIC PVT. LTD.

302555

31/01/2017
SANJEEV PATGAR
Quality Manager



CIVIL-AID

Ref: CIVIL AID: IIC: BL/2025/1/2017
Test Order dated: 24.1.2017

Date: 31.1.2017

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TEST REPORT ON HARDENED CONCRETE SAMPLE

Source of sample	:	Sample collected by Expert Technical Team Members
No. of samples tested	:	1 (One)
UIN	:	17002188
Customer's Reference	:	Letter No. IINNP/PR/1341/2016-17 dated 17.1.2017
Project*	:	Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Period of test	:	25.1.2017 to 30.1.2017
Condition of sample	:	Satisfactory
Technical Reference	:	ASTM : C 1324-2005 and ASTM : C 1084-10 and IS 4032 - 1985 (Reaffirmed 2009)

TEST RESULTS:

Sl. No.	Identification	Cement Content	
		(% by Mass)	(kg/Cu.m)#
1	Concrete sample collected from Embedded Steel	9.41	203.0

* As furnished by the customer.

Cement content is calculated by taking density of hardened concrete of 2152 kg/cu.m.
The density was calculated in the concrete core samples collected from the site.

Remarks:

1. The above calculation of cement content is based on the assumption that CaO content in Ordinary Portland Cement used for the concrete contains 63.50 percent by mass.
2. In the absence of original ingredients of concrete used, estimated cement content may be in error by 10 to 20 percent from the actual cement used.
3. The above test results are strictly applicable for the tested sample of concrete made out of 100% Ordinary Portland Cement only.

Note:

1. The results relate only to the items tested.
2. Report shall not be reproduced, except in full, without written approval of the laboratory.
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for CIVIL-AID TECHNOCLINIC Pvt. Ltd.

Dinesh H.T.
31/01/2017

DINESH H.T.
Manager - Lab



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Ref:CIVIL-AID:HC: BL/2025/1/2017
Test Order dated: 24.1.2017

CIVIL-AID

Date: 31.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON HARDENED MORTAR SAMPLE

Source of sample : Sample collected by Expert Technical Team Members
No. of samples tested : 1 (One)
UIN : 17002188
Customer's Reference : Letter No. HNMP/PR/1341/2016-17 dated 17.1.2017
Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Period of test : 25.1.2017 to 30.1.2017
Condition of sample : Satisfactory
Technical Reference : ASTM : C 1324-2005 and ASTM : C 1084-10 and IS 4032 - 1985 (Reaffirmed 2009)

TEST RESULTS:

Sl. No.	Identification	Cement Content		Estimated proportion of cement : sand (by volume)
		(% by Mass)	(kg/Cu.m)#	
1	--	23.65	492.00	1 : 3.10

* As furnished by the customer.

Cement content is calculated based on density of hardened mortar of 2080 kg/cu.m as per IS:875 (Part 1)-1987 (Reaffirmed in 2008)

Remarks: 1. The above calculation of cement content is based on the assumption that CaO content in Ordinary Portland Cement used for the mortar contains 63.50 percent by mass.
2. In the absence of original ingredients of mortar used, estimated cement content may be in error by 10 to 20 percent from the actual cement used.
3. The above test results are strictly applicable for the tested sample of mortar made out of 100% Ordinary Portland Cement only.

Note: 1. The results relate only to the items tested.
2. Report shall not be reproduced, except in full, without written approval of the laboratory.
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for **CIVIL-AID TECHNOCLINIC Pvt. Ltd.**

DINESH H.T.
Manager - Lab



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**CIVIL-AID**

Ref: CIVIL AID: WATER/BL/2025(a)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
 Bruhat Bengaluru Mahanagara Palike
 Commissioner Office
 N.R. Square
 Bangalore – 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002189
 Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
 Sample Identification / Location of sample collected * : From Circular
 Sample collected on : 21.1.2017 @ 4.00 p.m.
 Condition of sample : Satisfactory
 Period of test : 25.1.2017 to 30.1.2017
 Test Method : IS:456 – 2000 (Reaffirmed 2011)
 IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	402.78 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₃	254.99 mg/l	400 mg/l max.
3	pH Value	9.00	Shall not be less than 6

* As furnished by the customer

Note: 1. The results relate only to the items tested.
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for **CIVIL AID TECHNOCLINIC PVT. LTD.**



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 Manager - Lab



Ref: CIVIL AID: WATER/BL/2025(b)/1/2017
Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
Bruhat Bengaluru Mahanagara Palike
Commissioner Office
N.R. Square
Bangalore - 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
Customer's Reference : Letter No. IINNP/PR/1341/2016-17 dated 17.1.2017
UIN : 17002189
Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
Sample Identification / Location of sample collected* : From Raw Water
Sample collected on : 21.1.2017 @ 4.00 p.m.
Condition of sample : Satisfactory
Period of test : 25.1.2017 to 30.1.2017
Test Method : IS:456 - 2000 (Reaffirmed 2011)
IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	82.26 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₂	11.84 mg/l	400 mg/l max.
3	pH Value	7.30	Shall not be less than 6

* As furnished by the customer.

Note: 1. The results relate only to the items tested.
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for **CIVIL AID TECHNOCLINIC PVT. LTD.**



Dinesh H.T.
31/01/2017

DINESH H.T.
Manager - Lab

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**CIVIL-AID**

Ref: CIVIL-AID:WATER/BL/2025(c)/1/2017
 Test Order dated: 24.1.2017

Date: 31.1.2017

The Commissioner
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 Commissioner Office
 N.R. Square
 Bangalore – 2

TEST REPORT ON ANALYSIS OF WATER SAMPLE

Source of sample for testing : Sample collected by Expert Technical Team Members
 Customer's Reference : Letter No. HNNP/PR/1341/2016-17 dated 17.1.2017
 UIN : 17002189
 Project* : Inspection and Quality assessment of Existing Commercial Building at Ward No. 26 (Old), 95 (New), No. 1, 2nd Main, Sampige Road, Malleswaram, Bangalore
 Sample Identification / Location of sample collected * : From Softner Plant
 Sample collected on : 21.1.2017 @ 4.00 p.m.
 Condition of sample : Satisfactory
 Period of test : 25.1.2017 to 30.1.2017
 Test Method : IS:456 – 2000 (Reaffirmed 2011)
 IS:3025-1983 (Part 11, 24 & 32)

Sl No	Particulars	Results	Stipulations of IS:456-2000 (water for construction purpose)
1	Chlorides as Cl	90.77 mg/l	500 mg/l max. for RCC 2000 mg/l max. for PCC
2	Sulphates as SO ₃	9.61 mg/l	400 mg/l max.
3	pH Value	7.33	Shall not be less than 6

* As furnished by the customer

Note: 1. The results relate only to the items tested.
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for **CIVIL AID TECHNOCLINIC PVT. LTD.**



D. H. H.
 31/01/2017
DINESH H.T.
 Manager - Lab

ANNEXURE – III

CALCULATION & SKETCH

CALCULATIONS FOR STRUCTURAL ADEQUACY OF CANTILEVER SLAB

Effective depth as at site = 200-100-12/2 = 94 mm

Area of steel provided per meter of width
of slab (12 mm @150 c/c) = $\frac{1000 \times 113}{150} = 753.3 \text{ mm}^2$

Moment of resistance of section M_u = $0.87 f_y \times A_{st} d \left(1 - \frac{A_{st} \times f_y}{bd \times f_{ck}}\right)$

Grade of steel - Fe 415

Grade of concrete - M15 (as obtained from results of
core test)

$$M_u = 0.87 \times 415 \times 753.33 \left(1 - \frac{753.33 \times 415}{1000 \times 94 \times 15}\right)$$

$M_u = 19.9 \times 10^6 \text{ N-mm}$

$= 19.9 \text{ kN-m}$

Theoretical Verification of the design:

The loadings on the slab

Self Weight of the slab (thickness of the slab) = 0.2 x 25 5.0 kN/m²

Weight of screed of concrete

(250 mm thick as measured at site) = 0.25 x 21*

(*density as determined from the core extracted from screed)

5.25 kN/m²

Total uniform dead load 10.25 kN/m²

Point load at the tip due to r c parapet wall of height 1.3 m and 200 mm thick

$0.2 \times 1.3 \times 2.5 = 6.5 \text{ kN}$

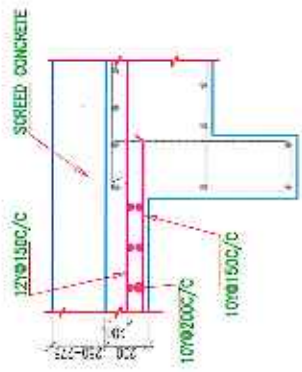
Unfactored bending moment = $10.25 \times 2^2/2 + 6.5 \times 2$

= 33.5 kN-m

Factored bending moment $= 33.5 \times 1.5 = 50.25 \text{ kNm}$

Moment of resistance of the section as exist at site = 19.9kN-m which is less than the Actual moment.

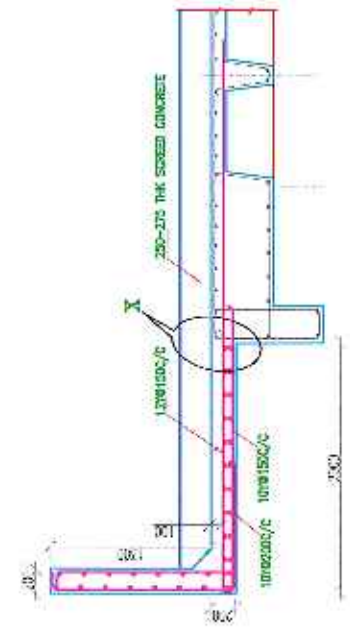
From the above, it is clear that the existing section is not capable of withstanding its own self weight along with the screed and parapet wall (without considering any live load on the roof)



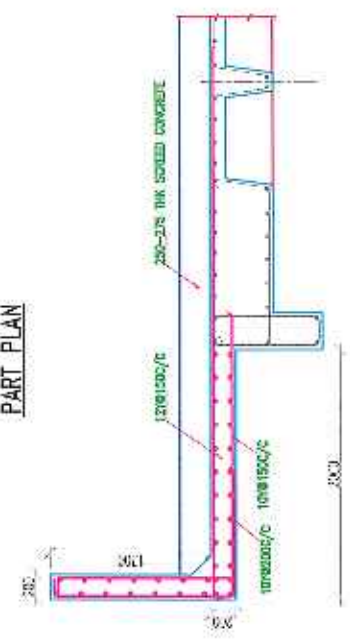
DETAIL AT X
EXISTING

PART PLAN

NOTE : ALL DIMENSIONS IN MM



SECTION -1
EXISTING



SECTION -1
AS PER STANDARD PRACTICE

FIGURE-1



2. ಡಾ|| ಕೆ.ಎಸ್. ಜಯಸಿಂಹ, ಮುಖ್ಯಸ್ಥರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.
3. ಡಾ|| ಆರ್.ನಾಗೇಂದ್ರ, ತಾಂತ್ರಿಕ ನಿರ್ದೇಶಕರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.
4. ಡಾ|| ಎಮ್.ಎಸ್.ಸುದರ್ಶನ್, ಸೀನಿಯರ್ ನಿರ್ದೇಶಕರು, ಸಿವಿಲ್ ಏಡ್ ಟೆಕ್ನೋ ಕ್ಲಿನಿಕ್ ಪ್ರೈ.ಲಿ., ಬನಶಂಕರಿ 2ನೇ ಹಂತ, ಬೆಂಗಳೂರು.

ಪ್ರತಿಯನ್ನು:

1. ಪೂಜ್ಯ ಮಹಾಪೌರರ ರವರ ಅವಗಾಹನೆಗೆ ತರಲು ಆಪ್ತ ಶಾಖೆಗೆ ಕಳುಹಿಸಿದೆ.
2. ಮಾನ್ಯ ಉಪ ಮಹಾಪೌರರು ರವರ ಅವಗಾಹನೆಗೆ ತರಲು ಆಪ್ತ ಶಾಖೆಗೆ ಕಳುಹಿಸಿದೆ.
3. ವಿಶೇಷ ಆಯುಕ್ತರು (ಯೋಜನೆಗಳು) ರವರ ಮಾಹಿತಿಗಾಗಿ.
4. ಪ್ರಧಾನ ಅಭಿಯಂತರರು, ರವರ ಮಾಹಿತಿಗಾಗಿ.
5. ಅಪರ ಆಯುಕ್ತರು (ಆಡಳಿತ) ರವರ ಮಾಹಿತಿಗಾಗಿ
6. ಅಪರ ಆಯುಕ್ತರು / ಜಂಟಿ ಆಯುಕ್ತರು (ಪಶ್ಚಿಮ ವಲಯ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
7. ಅಪರ ನಿರ್ದೇಶಕರು (ನಗರ ಯೋಜನೆ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
8. ಮುಖ್ಯ ಅಭಿಯಂತರರು (ಪಶ್ಚಿಮ ವಲಯ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
9. ಮುಖ್ಯ ಲೆಕ್ಕ ಪರಿಶೋಧಕರವರಿಗೆ ಕಳುಹಿಸುತ್ತಾ ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯ ಸದಸ್ಯರಿಗೆ ತಗಲುವ ವೆಚ್ಚವನ್ನು ಭರಿಸಲು ಸೂಚಿಸಿದೆ.
10. ಜಂಟಿ ನಿರ್ದೇಶಕರು (ನಗರ ಯೋಜನೆ - ದಕ್ಷಿಣ) ರವರು ತಾಂತ್ರಿಕ ತಜ್ಞರ ಸಮಿತಿಯೊಂದಿಗೆ ಸಹಕರಿಸಲು ಸೂಚಿಸಿದೆ.
11. ಕಾನೂನು ಕೋಶದ ಮುಖ್ಯಸ್ಥರು, ಬಿಬಿಎಂಪಿ ರವರ ಮಾಹಿತಿಗಾಗಿ ಕಳುಹಿಸಲಾಗಿದೆ.
12. ಕಛೇರಿ ಪ್ರತಿ