


## Condition Survey Report For Industrial Structure

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# Condition Survey Report For Industrial Structure

- Standard Disclaimer:
- The Report has been prepared to the Best of Practices in the Industry.
- Client Name and Address is not disclosed as part of Work Contracts Clauses.
- Documentation, Images, Analysis, Problem and Solution are part of Saaibi.com during its Association with DGC Pvt. Ltd 
- Refer to Title Page for Terms And Conditions For Provision Of Services.





### What Does Condition Survey Report reveals ?

- An Overall Health Condition of Home / Building much like a Doctor examines a patient.
- After examining through Visual Inspection An Engineer may suggest for Non Destructive Test if required for complete Health Check Up much like Doctor prescribe for Body Check Up.
- This Tests and Inspection will reveal whether the building is Safe or Require Repairs, Rehabilitation or Strengthening as the case may be.
- Suggest Repair and Retrofitting measures which needs to be taken as per building demand.

### How does it Serves the Purpose ?

- To Understand The General Condition of Home / building.
- Finding Area of Distress which requires Repairs, Rehabilitation or strengthening.
- To Enhance Life of Building and Save Lives of Humans and Building.





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## 1) Introduction:

The Company Industries Limited is an Indian-based Chemical manufacturing company. The company was founded in 1960. It manufactures Various types of Industrial products and has Pan India Presence.

One of the oldest manufacturing plant is at Jalgaon, which majorly manufactures Chemicals and other product. This plant has different building units which are around 30-year-old. Their functioning purposes has also changed with the time and many repairing works has also done on these industrial building units. Major structural changes have also done on some of the building

In Lieu of the above Work order was awarded to carry out Condition survey report which includes, Visual Inspection, Non Destructive Testing at site, Analysis and giving out Recommendation based on Survey Report for Solutions and further Safe Guard of Structure.

## 2) General Information

No. of levels (including ground floor and roof);	4 levels = Ground + 3 Upper Floors as per Architectural Drawing.
Height of building	(Height: 29.3 metres)
No. of basements	None
Type of building	Industrial
Type of construction	RCC Frame and Steel section Structure with Infill Block and RCC Slab
Probable age of building	30 years
Building Information	Building consists of Two section Flame Proof Section and Non Flame Proof Section
Dimensions	Length: 75.46m x Breadth: 18.46m
Foundation type / Depth	Type: Isolated RCC footing; as per Structural Drawing.
Other information (if any)	Structural and Architectural Drawing Available.

## Check List for Inspection of Building

Item	Description	Done	Not done	Remarks
Pre Inspection				
1.	Ensure that Work Order/ LOI was issued by the Contractor	✓		Yes
2.	Check whether location plan was provided	✓		Yes
3.	Check whether architectural drawings were provided	✓		Yes Available
Inspection				
1.	Location of structure to be surveyed is as per available drawing	✓		Yes
2.	Exterior inspected with photographs	✓		Yes
3.	All floors inspected with photographs	✓		Yes
4.	All cracks photographed and recorded with complete details in field format <i>Cracks visible on the surface of the walls recorded as non - structural cracks and through cracks to be identified as structural cracks</i>	✓		Yes
5.	Any Spalling or steel corrosion observed? If so, photographed and recorded with complete details in field format	✓		Yes
6.	General condition of surrounding ground of building studied to detect any subsidence/upheaval and recorded	✓		Yes
7.	Verticality and Deflection (Based up on visual observation) No test conducted	✓		Yes inspected
8.	Checked major overhangs such as chajjas, balconies, canopies for defects or cracks (if any)	✓		Checked
9.	In reinforced concrete structures, signs indicating defects like Spalling etc. in structural elements like columns, beams, slabs checked and recorded	✓		Yes
10.	Beam/column joints inspected for cracks / defects (If any)	✓		Yes inspected
11.	Any damage to non - structural elements like plaster cracks in wall, vegetation growth, water leakages, dampness and seepages etc. checked and recorded.	✓		Yes
12.	Any other signs of damages, distress, deformation or deterioration observed? If so, photographed and recorded with complete details in field format	✓		Yes inspected
13.	In-situ Evaluation and Laboratory testing	✓		Yes



### 3) Condition Survey

#### Definition:

Condition Survey is an examination of concrete for the purpose of identifying and defining of distress.

#### Objective:

The Objective of Condition Survey of a building structure is

- a) To identify - cause of distress and their sources.
- b) To assess - the extent of distress occurred due to corrosion, fire, earthquake or any other reason,
  - the strength of the structure,
  - its ability to rehab.
- c) To prioritise the distressed elements according to seriousness for repairs and
- d) To select and plan the effective remedy.

#### Stages:

Stages for carrying out Condition Survey, largely depend on field conditions, maintenance and have a direct relation with the pattern of distress, whether localised or spread over.

Condition survey of a building is generally in Seven different stages to identify the actual problem so as to ensure that a fruitful outcome is achieved with minimum efforts and at least cost. The Seven stages of Condition survey described are

- a) Inspection b) Data Collection & Planning c) Non destructive Testing d) Analysis e) Problem Identification f) Workable Solutions and g) Safe Guard



## 4) Visual Inspection



**IMAGE 01**

View showing the delamination of concrete from structural as well as non-structural member. Minor cracks are also present in the corner columns of the structure.



**IMAGE 02**

View showing the cut out in the concrete from slab. Due to cut out delamination of concrete occur and reinforcement has exposed.



**IMAGE 03**

View showing the repair and patchwork in slab for connection.



**IMAGE 04**

View showing the uneven and unfurnished cut out in slab for connection.



**IMAGE 05**

View showing the Repair of cut out done in slab for connection.



**IMAGE 06**

View showing the cut out done in slab has left unrepair.



**IMAGE 02**  
View showing the delamination of concrete in slab and reinforcement of slab has exposed.



**IMAGE 09**  
View showing the delamination of concrete in slab and reinforcement of slab has exposed.



**IMAGE 08**  
View showing the vertical crack and dampness in column.



**IMAGE 10**



**IMAGE 11**  
View showing the major delamination of concrete from RCC, pulling of staircase and reinforcement of it has exposed.



**IMAGE 12**  
View showing the delamination of concrete in RCC column.





**IMAGE 25**

View showing the major cracks in the beam.



**IMAGE 26**

View showing the major crack in the repaired column.

## Quinacridone Plant



**IMAGE 27**

View showing the major crack in the column as well as in beam and reinforced expanded in column.



**IMAGE 28**

View showing the major crack in the column as well as in beam. The images inside of Quinacridone Plant is not available as it was not permitted to enter.

## Godown line



**IMAGE 29**

View showing the major crack in the column as well as in beam.



**IMAGE 30**

View showing the spalling of concrete and exposed reinforcement in beam.



### 5.3.5, Entrance Hall



**IMAGE 24**

View Showing damped and deteriorated outer portion of entrance of office building.



**IMAGE 25**

View Showing damped and deteriorated outer portion of entrance of office building.



**IMAGE 26**

View Showing minor cracks in the wall of entrance portion of main office building.



**IMAGE 27**

View Showing delamination of cover concrete and reinforcement exposed in slab of entrance portion of main office building.



**IMAGE 28**

View Showing cracks in beam at entrance of main office building.

## 5) Non Destructive Testing

# NON-DESTRUCTIVE TESTING

### 9. NON-DSTRUCTIVE TESTING

On the basis Visual Inspection, following Non Destructive Testing (NDT) decided to carried out:-

#### Purpose of NDT Test:-

- To Determine the existing Compressive Strength of concrete.
- To Obtained the Quality of Concrete.
- To analysed the carbonation and oxidation of concrete and reinforcement.
- To check the reinforcement details of structural members.

#### Based on that following tests carried out:-

1. Quality of Concrete – ULTRASONIC PULSE VELOCITY (UPV TEST).
2. Corrosion/ Oxidation in Existing Reinforcement – HALF CELL POTENTIAL (HCP TEST).
3. Carbonation in Concrete Surface – CARBONATION TEST.
4. Hardness of Concrete – REBOUND HAMMER.
5. Compressive Strength of Concrete – Cut And Pull Out Test (CAPO) TESTING.
6. Reinforcement Analyzed – REBAR MAPPING (As per drawing and size condition).
7. Chemical content in Concrete – Chemical Testing .
8. Depth & Type of foundation – Foundation Analysis .

#### Note:

1. Above testing methodology are present in report along with results.
2. Results based on Quality, Strength, Corrosion Potential, Existing status of structures.

### ULTRASONIC PULSE VELOCITY TEST

#### Application:

#### These tests are primarily done to establish:

1. The homogeneity of concrete.
2. Presence of cracks, voids and other imperfections.
3. Changes in quality of concrete over time.
4. This test does not establish compressive strength of tested concrete.

UPV Tests are done in accordance with Indian standards IS: 13311 (Part 1).

#### Procedure:

1. The concrete surface where probes are to be applied is cleaned properly.
2. Grease is applied on the test surfaces.
3. The probes are pressed on the surface of the structural element to remove air gaps.
4. Distance between the two probes is noted.
5. Read time taken for the ultrasonic pulse from the instrument.
6. Calculate Velocity=distance / time.

#### Methods:



Direct Method



In-Direct Method



Semi-Direct Method

## HALF CELL POTENTIAL TEST

### Application:-

These tests are used to assess the probability of corrosion in reinforcement. HCP Tests are done in accordance with ASTM C876 standard.

### Procedure for Half Cell Potential Tests:-



1. Identify test location & drill a hole in the concrete to reach the reinforcement.
2. Establish electric contact with the reinforcement.
3. Place the half cell at various locations on the concrete surface & measure voltage in voltmeter.
4. Correlate the obtained voltages to probability of corrosion as per ASTM standard.

HCP	Probability of corrosion
Cu/CuSO <sub>4</sub> (mV)	[ASTM, 2015]
>+300	Less than 10%
-200 to -350	10% to 90%
<-350	Greater than 90%

Sr. No.	Member ID	Level	Element	V (-Mv)	Probability of corrosion
1	C1	Silt	Top	270	50%
2	C1	Silt	Mid	271	50%
3	C1	Silt	Bottom	275	50%
4	C2	Silt	Top	280	50%
5	C2	Silt	Bottom	290	50%
6	C3	Silt	Top	267	50%
7	C3	Silt	Mid	290	50%
8	C3	Silt	Bottom	267	50%
9	C4	Silt	Top	277	50%
10	C4	Silt	Bottom	281	50%
11	C5	Silt	Top	269	50%
12	C5	Silt	Bottom	288	50%
13	C6	Silt	Top	280	50%
14	C6	Silt	Bottom	261	50%
15	C7	Silt	Top	277	50%

16	C7	Silt	Bottom	Column	269	50%
17	C8	Silt	Top	Column	270	50%
18	C8	Silt	Mid	Column	290	50%
19	C8	Silt	Bottom	Column	269	50%
20	C9	Silt	Top	Column	270	50%
21	C9	Silt	Mid	Column	287	50%
22	C9	Silt	Bottom	Column	281	50%
23	C10	Silt	Top	Column	281	50%
24	C10	Silt	Mid	Column	288	50%
25	C10	Silt	Bottom	Column	281	50%
26	C11	Silt	Top	Column	289	50%
27	C11	Silt	Mid	Column	281	50%
28	C11	Silt	Bottom	Column	270	50%
29	C12	Silt	Top	Column	288	50%
30	C12	Silt	Mid	Column	284	50%
31	C12	Silt	Bottom	Column	286	50%
32	C13	Silt	Top	Column	251	50%
33	C13	Silt	Mid	Column	284	50%
34	C13	Silt	Bottom	Column	269	50%
35	C14	Silt	Top	Column	281	50%
36	C14	Silt	Bottom	Column	281	50%



	
Conducting UPI Test	Conducting Rebound Hammer Test
	
Conducting H-Ca II Potential Test	Conducting Rebar Scanning Test

	
Conducting Carbonation Test	Extracting the core sample
	
Conducting Chemical Analysis	Conducting core Test

## 6) Problem Identification

### Problem identification And RECOMMENDATION

1. As per Visual Observation.
2. As per NDT Test

PROJECT - 22 FRIESTATE VAFS, GURBAT

### RECOMMENDATION AS PER TEST PERFORMED AND VISUAL OBSERVATION.

In NDT test result analysis, the 2 types of solution have given.

1. Conventional Repair is required
2. Strengthening is required

Following are the detail description of the term conventional repair and strengthening.

#### 1. METHODS FOR REPAIRS TO MEMBERS:-

##### A. CONVENTIONAL REPAIRS:-

###### i. Honey-Combing Surface:-

- a. Area where there is a honeycombing that area need to grout with low viscosity ~~monopol~~.
- b. Then it should be treated with Polymer Modified Mortar at certain ratio.

###### ii. Exposed Reinforcement/ Hollow sound /Spalling

- a. Where there is exposed reinforcement, initially a loose concrete around that should be removed and then area is to be spread with water jet.
- b. Later on Antioxidant to be applied on the reinforcement surface prior to that rust should be removed with acid by using wire brush.
- c. After that a nozzle to be inserted at certain spacing and that should be grout by using low viscosity ~~monopol~~.
- d. Then, bond coat to be used on that surface to bond the new polymer mortar layer on it.
- e. Further Polymer Modified Mortar (PMM) layer to be used on surface in ratio of (1:4:8).

###### Efflorescence/ Dampness:-

- a. Area where there is efflorescence, chip it off with chisel.
- b. Spray Water- cement in the form jet on to surface, so that air pocket should be expelling out.
- c. Use Corrosion Inhibitor on the surface along with cement in that surface in ratio of (1:1).
- d. After using passivate layer a surface to be finished.

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###### iii. Cracks Construction /Voids/Beam- Slab Joints cracks:-

- a. A portion of cracks to be cut in structure with grinder until a depth of crack is determined.
- b. Later on a water jet sprayed to be carried out that air pockets present in voids should be closed.
- c. Now Using Poly bonding agent with cement in ratio (1:1).
- d. Filling that cracks with cement plus bonding agent with leveling and filling in low viscosity that it may fill up all the voids and pockets.

###### iv. Exposed Reinforcement:-

- a. Area need to repaired by conventional method and also jacketing wherever strength require.

#### 2. Strengthening:

Where the member shows low strength or insufficient cross section or reinforcement in NDT test result, jacketing should be provided for increasing the area of section or reinforcement and hence member strength.

#### 2. Building Unit wise and Floor Wise Recommendation Summary based on Visual Inspection and NDT Test Result.

##### A) Violet Building

In Violet building on the basis of NDT test and visual inspection

In Ground Floor on the basis of NDT Test 11 column require strengthening, whereas only 4 column require conventional repair and 2 column require conventional repair after site inspection of them. 1 slabs require conventional repair.

In First Floor on the basis of NDT Test 11 column require Strengthening, 3 column require conventional repair. 1 slab require conventional repair 3 Slabs require conventional repair after site inspection.

In Second Floor on the basis of NDT Test 10 column strengthening, whereas only 7 column require conventional repair and 3 column require conventional repair after site inspection. 6 slabs require Conventional repair and 2 Staircase flight between second and third floor require conventional repair.

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## 7) Workable Solution

Workable Solutions are offered in the form of Repair, Rehabilitation or Strengthening Scheme in the form of Methodologies of Work to be adopted for Safety, Durability of Structure.

### 9.2 Methodology for Grouting of Structural Element using epoxy & Cement grout.

#### Step 1 – Identification of beam location for grouting



Identify and mark the areas for epoxy injection grouting. After this surface preparation is done by grinding then the surface and is cleaned with dry rag. After cleaning, if cracks are present the cracks become very clear and can be easily seen. If the cracks are deep, then the cracks are opened by forming V-shaped groove.

#### Step 2 – Drilling holes for nozzles

Drill holes at least 14mm diameter and 50 mm deep in structure throughout. Holes to be drilled in a staggered manner at 500 to 800 mm c/c spacing covering adequately the area proposed to be grouted. Holes spacing can be altered as per site conditions. If honeycombing present, then in such area it is to be placed @ 600s per sqm.

#### Step 3– Surface preparation post drilling of holes

Remove coarse debris and dust in drilled holes by blowing oil free compressed air, if available with air compressor, otherwise with hand operated blow out pump. Concrete surfaces required to be grouted shall be free from all loose and unsound materials by means of mechanical abrasion using stiff wire brushes, after removing all loose areas with chisel and hammer. Area shall be made free from any deleterious materials, such as oil, dust, dirt, etc. by means of oil free jet of compressed air. All prepared concrete surfaces shall be thoroughly inspected.

#### Step 4 – Inserting injection nozzles in drilled holes



Insert 12mm diameter Teflon nozzles in holes drilled and fix them by sealing only its sides with epoxy putty (R & M levelling mortar).

#### Step 5 – Preparation before grouting



Blow the compressed air to ensure removal of even fine dust particles from the cracked surface, which could obstruct the free flow of grout material and impede its bonding with cracked

#### Step 6 – Preparation of injection grout



Epoxy grout shall be prepared with ratio of base & curing agent as specified in table below. It seals cracks in concrete and increases the flexural strength of the member.

Base	High Molecular Weight Polymer
Mix Proportion	Base : Curing Agent
Viscosity	275 gms : 32 gms
Adhesive	Non Toxic on skin
Viscosity	Less than 9 cps (W sterilizer)
Specific Gravity	1.15 to 1.18
Compressive Strength as per ASTM C-1067 (7 Days)	140 N/mm <sup>2</sup>
Flexural Strength as per ASTM C-1067 (7 Days)	15 N/mm <sup>2</sup>
Tensile Strength ASTM C-1067 (7 Days)	10 N/mm <sup>2</sup>
Applications	By gravity pouring / pressure grouting/bedding
Pre Life	30 minutes for 300 gms. mix at 20°C
Shelf Life	1 year in tightly sealed containers
Packing	5 kg, 10 kg
Cleaning	Thinner 7-30



pressure is must so that the **U666** should get properly embedded in the epoxy for supreme bonding with concrete which results in developing a better strength.

#### Step-7: Drilling for Anchors

After completing the grinding work, the next step is to go for the drilling, for which marking has to be done at the centre of the overlapping distance as specified (or) given in the drawing. The depth of the drilling is as per the size of **U666** anchors which is almost 50mm to 60mm long. Thereafter, the **U666** anchor is inserted inside the drilled area and **U666** is spread in such a way that it looks the joint of overlap.

#### Step-8: Fixing of Fiber anchors

After completing the wrapping work, **U666** anchors are applied at specified spacing on structural element. The anchor is inserted in the drilled hole as shown in the figure and then protruding fibres are manually spread in circular shape so that it should give a locking effect from all 360°. The purpose of placing **U666** anchor is to hold the ends & joints of the wrap so that it should not peel off from the ends in any circumstances and it provides a long lasting life to the **U666** wrapping system.



#### Step - 9: Application of fire protective coating

It is advised to provide fire protection coat post strengthening on the structural member to fire proof the members.

### 9.4 Methodology for Strengthening of Structural Element with RC Jacketing

#### Step-1: Removal of loose concrete



Removal of loose concrete from the member so as to prevent from the deterioration or de-bonding issues that entire loose particle from the concrete should remove. After removal of loose concrete entire surface should be wetted by spraying water.

#### Step-2 : Additional Reinforcement



Based on the design aspect additional reinforcement is added to concrete with maintaining of proper alignment and cover.

#### Step-3: Application of Anticorrosion to Reinforcement.



After the removal of the loose mass of concrete for surface preparation the existing reinforcement is exposed to the atmosphere which is treated with the anticorrosive treatment to avoid corrosion of the steel.

#### Step-4: Drilling and fixing of Shear Connectors



After the application of the bond coat the drilling is carried out, after the drilling the drill hole is cleaned with blower and the shear connectors are fixed with the help of epoxy. The depth of the drill hole and the spacing depends on the design of jacking.

## 8) Safe Guard

To Safe Guard Wealth Of Nation it is of utmost importance that proper Maintenance is taken throughout the Years so that our structures remain Usable for their intendent life and longer. Below is the list of Do's and Don'ts for Structures

For proper maintenance of any RCC Structure, following are to be followed:

### Do's:

- Thorough Structural Audit should be done every 5 years for the buildings aging between 15 to 30 years and at every 3 years for building aging beyond 30 years.
- In case of any of the following concerns, bring to the notice of consulting Structural Engineer:
  - > Cracks in Columns, Beams or Slabs.
  - > Swelling in Columns.
  - > Visible deflection in the Beams/Slab.
  - > Vibration noticed while moving or shifting any equipment in the slab.
- Carry out timely repairs of any parts of the building under the advice and supervision of consulting Engineer.
- Provide water proof cement coating on the exterior faces of the building regularly.
- Ensure the maintenance of the false ceiling at regular intervals.
- Checking all drainage and water supply service pipe lines and its connections at every 2 years and replace the defective ones.
- Checking up internal plumbing lines and joints to trace leakage if any from a licenced plumber.
- Getting the house drains cleaned once in every 2 years or anytime when there is a choke up or overflow of drain waters from the manholes.
- Checking of waterproofing on the terrace and checking for repairs to prevent any leakages.
- Common service areas and common compound areas should be kept in good condition.
- Underground and Overhead tanks should me checked and maintained properly.
- Keep the terrace clean and maintain especially before, during and after monsoon.

### Don't s:

- Unauthorized additions over the designed load for the structure should not be allowed.
- Never allow any internal structural changes/ alterations like changes of position of the rooms.
- Do not allow structural additions if not approved by municipal authority or a consulting structural engineer.
- Do not let unwanted vegetation grow near the structure.
- Do not do any of the following without professional engineer support:
  - > Repairs of structural members.
  - > Modification of existing plan of the building.
  - > Changing of floor finish.
  - > Structural alteration in view of ~~proper~~ <sup>proper</sup> designing.
  - > Any kind of renovation of the building.



## STRUCTURAL AND ARCHITECTURAL INFORMATION BASED INSPECTION (SAAIBI)



संरचनात्मक और वास्तुकला आधारित निरीक्षण एवं जानकारी।

### Why Building Inspection:

- Due to Bad Workmanship, NO Quality Control, Weathering, NO Maintenance, Deterioration, Over loading, Structural cracks are observed on Buildings.
- These need to be addressed and repaired to maintain Building Structural Integrity and to prevent potential Failure.
- Regular Inspection and Timely Repairing is the key to Long lasting Buildings.


### How can we help:


- We Conduct Inspection, Do Non Destructive Tests .
- Detect Structural defects and Potential hazards to Structure and Recommend Repairs, Retrofit and Strengthening.
- We take Building inspection for Residential, Commercial and Industrial structures.





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Safe Building, Safe YOU.

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