CHAPTER 1 – Introduction

Building inspections have been carried by JKR personnel at the districts whenever there is a complaint or request from the Client. However, until today there is no standard format of reporting being devised for the inspectors.

Thus, inspection reports that were sent to the Forensic Unit of JKR headquarters were usually of varying standard and format. The quality of reporting generally depends on the knowledge and competency of the inspectors. Due to their lack of technical knowledge, some of the building problems which are minor and can be resolved at the district level were also sent to the Forensic Unit for its assistance. These requests add to the already heavy work load of the Forensic Unit and hindering it from focusing on problems that are more pressing or more critical.

To tackle this problem a standard inspection report form named *Building Conditions Inspection Report Form (**JKR/Bul/1-06**)* was developed. The inspection report form also has a checklist of components and problems[*] to be inspected which acts as a guide for the inspectors to fill in the form. Though the form contains all the typical components and problems encountered in buildings, it is aimed for the inspector to inspect only the locations in the building where problems are reported. The inspector should note that this is not a report form for periodic inspection but rather a visual investigation to report specific problems.

[*] *problems refer to defect, damage or deterioration. Refer to Chapter 3 for detail description.*

From the inspection report, the building or district engineer would be able to decide whether the problems are structural or non-structural in nature. The District will only tackle non-structural problems. Structural problems should be referred to the State.

The purpose of this Handbook is to guide the technicians or technical assistants at the districts to conduct Conditio*ns inspection* of buildings. The Handbook provides the inspectors with:

i. Knowledge on various components of buildings
ii. Typical types of problems on buildings. Each type of problems is supplemented with photographs or figures for ease of understanding.
iii. Guides on filling in the inspection form, and
iv. Recommendations on the action plan where basic solutions to non-structural problems are given.

Both technical content and language have been simplified to make this handbook easy to understand by inspectors who have poorer knowledge in engineering and/or English.

When inspecting the building, the inspector should bring along this handbook as it provides guidance to the inspectors in filling in the form and determining the types of problems. However, it should be noted that this Handbook covers only the inspection of concrete buildings.

It is envisaged that with this Handbook, every districts would be able to produce standardised and systematic reporting of building problems. More importantly, minor problems that are not of structural significance can be tackled at the district level.

Notwithstanding, the competency of the inspectors is of utmost importance to ascertain that the inspections are properly carried out and the problems correctly diagnosed. Hence, it is recommended that would be inspectors are properly trained on Building Conditions inspection before they are allowed to conduct inspection of buildings.

It must be stressed that this handbook aims only to support and guide a suitable inspector on how to inspect a building on behalf of his engineer. The final decision on the actions required will eventually be the responsibility of the Building Engineer and District Engineer.

CHAPTER 2 –Building Components

Before the inspector starts doing his inspection work, it is important that he has some basic knowledge on structural behaviour of a reinforced concrete frame structure under load, concrete properties, and mechanisms of deterioration.

The figure below shows a standard reinforced concrete frame building.

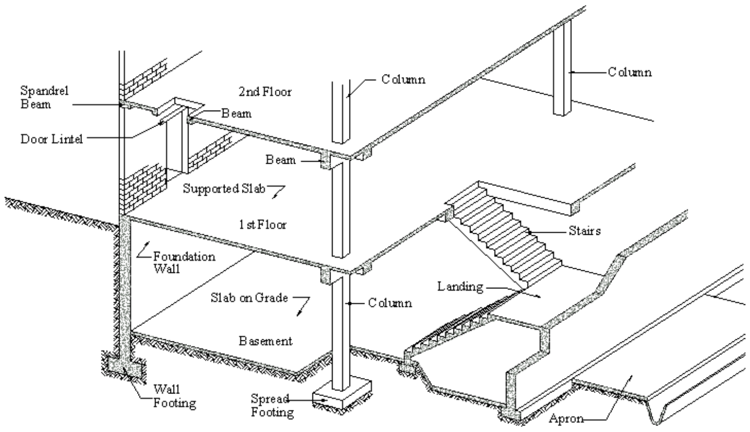


Fig. 2.1 Structural Elements in a Standard RC Frame Building
(Adapted from ref: 8)

The components of a building can be broadly divided into structural elements and architectural elements.

Structural elements are those needed to carry the loads. Examples of structural elements are beam, column, wall, floor slab and staircase. Architectural elements do not carry loads and are meant for aesthetic purposes only. Architectural elements include cladding, apron, render or plaster to the wall, screed on the floor, doors and windows.

Beams are structural members designed to withstand load that is transverse to their main axis. The load effects induced in a beam are mainly bending, torsion and shear (see Figures 3-8, 3-9 and 3-10). Columns are structural members expected to carry compression (parallel to their axis) and bending forces. The behaviour of beams and columns under uniformly distributed load can be seen from Fig. 2-2 and Fig. 2-3, respectively.

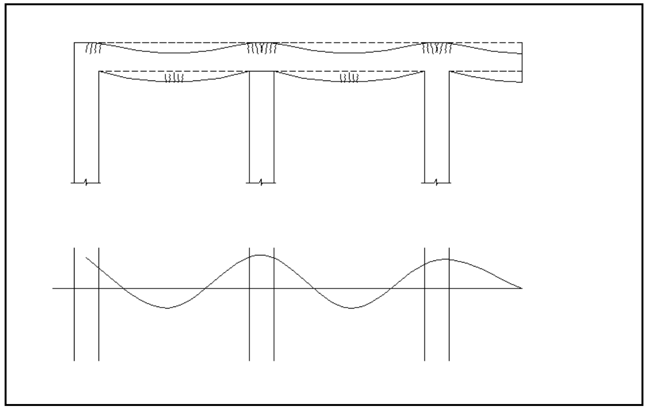


Fig. 2-2 Bending effect of a continuous beam under a uniformly distributed load

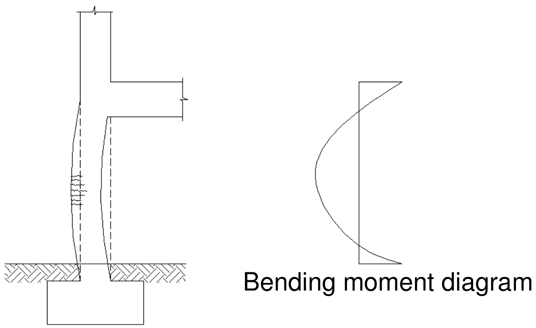


Fig. 2-3 Bending effect of a column under vertical load

Note that in both cases, the tension sides of the members can be predicted from the deflected shape of the member under load; or more objectively, from the bending moment diagrams. Concrete is known to possess high resistance in compression but weak in tension. This is why engineer provides steel reinforcing bars in the tension zone of the structural member of an RC construction.

Slab and Wall are also structural members. Floor slab which spans over the beams is known as a one-way slab. Its behaviour can be reckoned as individual strips of beams. In the case of the two-way slab, which has beams in an approximately square grid, the behaviour may be more complex. Yield-line theory offers some ideas on how a concrete slab, either one-way or two-way would fail under a load (see Fig. 2-4 and Fig. 2-5).

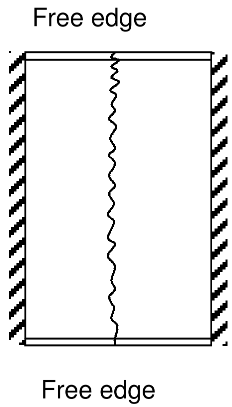
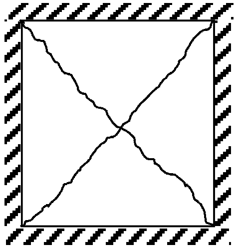
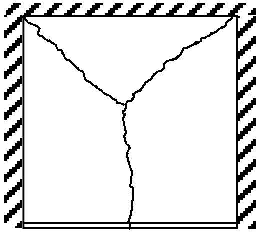


Fig. 2-4 Yield lines in one-way slab



a) Four simply supported edges



Free edge

b) Three simply supported edges

Fig. 2-5 Yield lines in two-way slab

HANDBOOK FOR CONDITIONS INSPECTION

CHAPTER 3 – Types of Defects, Damage and Deterioration

3.1 Introduction

This chapter briefly describes the types of defect, damage and deterioration commonly found in reinforced concrete buildings. Before proceeding further, it is important that the inspectors clearly understand the meaning of the three terms mentioned above i.e.:

i. Defect is a problem caused by deficiency in either design, specification or workmanship,

ii. Damage is a problem caused by change in use of building, impact, abrasion and chemical spillages, and

iii. Deterioration is a problem caused by the worsening of the material.

For the purpose of this handbook the term ‘problem’ shall be used to include defect, damage and deterioration. However, for the Building Condition Inspection Report Form, the term ‘damage’ is used to cover the above problems. This is to be consistent with the form used by Districts JKR in inspecting bridges which used the term ‘damage’ to cover all types of bridge problems.

In this chapter, each type of problem is explained in a simple, easy to understand description supplemented with photographs or diagrams.

The number preceding a type of problem refers to the damage code for ease of referencing with the inspection checklist form. As an example, ‘7 Spalling’ means 7 is the damage code number and spalling is the type of damage.

The number codes used in this guideline are the same as the number codes used in the 'Bridge Inspection Guide' published by Road Engineering Association Malaysia (REAM). The reasons for using the same number codes are:

i. familiarity of the technicians at the districts with these number codes and

ii. To maintain a uniform damage code within JKR.

3.2 Types of Defect, Damage and Deterioration

6 Cracks

A crack is defined as a fracture in concrete which extends partly or completely through the member. Cracks in concrete occur as a result of tension introduced in the concrete exceeding the tension capacity of the concrete.

Cracks in the inspection form are categorised into four (4) types based on their causes. The types of cracks are as described below:

i. Cracks due to intrinsic movement in the concrete under external or internal restraint.

ii. Cracks due to corrosion of underlying steel reinforcement.

iii. Cracks due to externally applied load and

iv. Cracks due to differential movement or settlement of the building.

Type (i) and (ii) cracks are non-structural and normally do not cause detrimental to the structure. On the other hand, cracks under type (iii) and (iv) are structural and may lead to a more serious problem.

As each of these cracks causes different impact on the building structure, they are further divided to the following sub-code:

6a Cracks – intrinsic

6b Cracks – corrosion-induced

6c Cracks – load-induced

6d Cracks – settlement.

The descriptions on each type of cracks are given below.

6a Cracks – intrinsic

These cracks are produced when a volumetric change in concrete due to shrinkage, creep, hydration* and changes in temperature is checked by:

i. Restraint at member support (external restraint) and/or

ii. Differential expansion or contraction of the concrete surface relative to the interior concrete mass.

Cracks due to intrinsic movement in concrete can be in the following forms:

i. Random pattern

ii. Following line of steel reinforcement,

iii. Fine vertical cracks at regular intervals in beams,

iv. Fine vertical or horizontal cracks at regular intervals in columns

v. Transverse cracks at regular intervals in slabs.

* *Hydration is a reaction of cement powder in the presence of water, which in time will form a hardened cement paste.*

Figures 3-1 to 3-5 show the common crack patterns for these types of cracks.

Fig. 3-1: Typical random patterned shrinkage cracks in a roof slab.

Fig. 3-2: Transverse cracks due to thermal contraction in concrete slab. The whitish deposits produced by water leaking through the cracks make the cracks appear more distinct.

Fig. 3-3: Equally spaced transverse shrinkage cracks in the layer of plasters on beam. This crack pattern can also occur on columns.

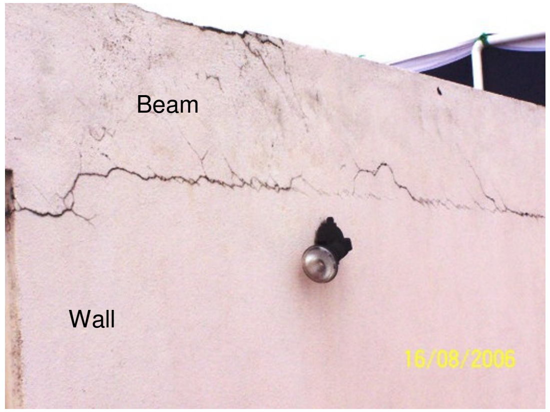


Fig. 3-4: Shrinkage cracks in the layer of plaster along interface between beam and brickwall.

Fig. 3-5: Typical random shrinkage cracks in the layer of plaster on a wall.

6b Cracks – corrosion-induced

These cracks develop when the underlying steel reinforcement corrodes and expands, thus exerting pressure on the concrete and causing it to crack. The cracks normally follow pattern of the reinforcement.

Corrosion of reinforcement is normally caused by:

i. carbonation of concrete whereby carbon dioxide in the air enter the concrete and react in the presence of moisture making the concrete less alkaline[*] and reinforcement susceptible to corrosion, or

ii. chloride entering the concrete from marine environment and causing the reinforcement to corrode when its concentration exceeded the threshold level

[*] *Alkalinity of concrete (pH value in access of 12) protects reinforcement against corrosion but carbonation reduces its alkalinity (pH to 7) and protection against corrosion.*

Fig. 3-6: Cracks seen at the soffit of a beam caused by expansion of corroded reinforcement.

Fig. 3-7: Vertical crack in a column along the line of reinforcement indicating corrosion of the underlying reinforcement.

6c Cracks – load-induced

These are structural cracks which are caused either by:

i. deficiency in design,

ii. imposed loading greater than the intended design, or

iii. construction fault

These cracks are considered serious as they are an indication of deficiency of the affected component and should be reported immediately to State JKR.

The patterns of load-induced cracks are normally as described below.

a. Vertical cracks near soffit of beam (bending)

These cracks developed when the imposed load near the mid-span a beam had exceeded the beam's structural capacity. The cracks normally occur near the mid span of the beam and propagate vertically upwards from the underside of the beam.

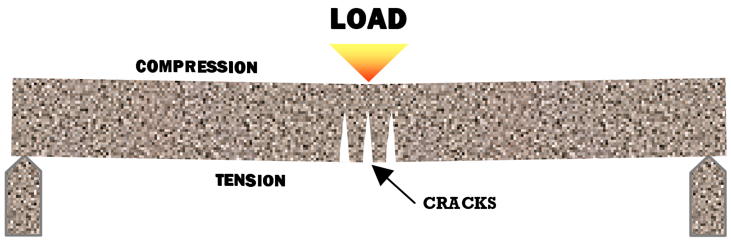


Fig. 3-8: Vertical cracks near the mid-span propagating from the beam soffit.

b. Diagonal cracks near beam supports (shear)

These cracks develop as a result of shear failure of beam. The cracks normally develop near the support and appear as diagonal lines as shown in Fig 3-9.

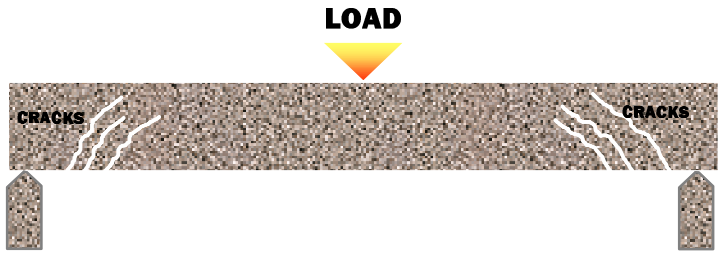


Fig. 3-9: Diagonal cracks in beam near the support due to shear failure.

c. Diagonal spiral cracks around beam (torsion)

These cracks develop due to torsional rotation (twisting) of the beam. The cracks will form the diagonal spiralling around the member as shown in the Fig. 3-10.

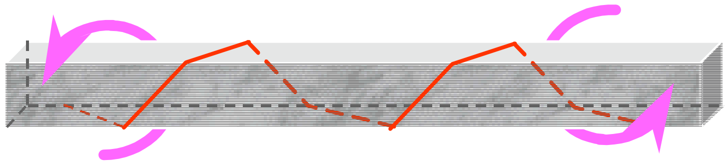


Fig. 3-10: Diagonal spiral cracks in the beam member due to torsional rotation.

6d Cracks –Settlement

These cracks develop when there is some movement of the foundation caused by soil subsidence or heaving or inadequacy of the foundation. Soil subsidence normally will cause cracking of the apron and/or perimeter drain (Fig. 3-11 and 3-12).

Fig. 3-11: Cracks at pedestrian footpath besides a building due to soil subsidence. The building however, is not affected by the subsidence.

Fig. 3-12: Severe cracks in the apron due to soil subsidence.

Sometimes the foundation itself may settle and result in cracking of the wall. It should be noted that the cracks are more severe if they are the results of differential settlement of the foundation. The cracks due to settlement are normally predominantly diagonal and follow the vertical and horizontal mortar joints of brickwork. These cracks should be handled critically as the structural integrity of the building may have been impaired. Some examples on cracking due to differential settlement are given in figures below.

Fig. 3-13: Diagonal crack in a wall at a staircase on the ground floor due to differential settlement of the foundation.

Fig. 3-14: Diagonal crack in a wall propagating from a corner of a door frame due to differential settlement of the foundation.

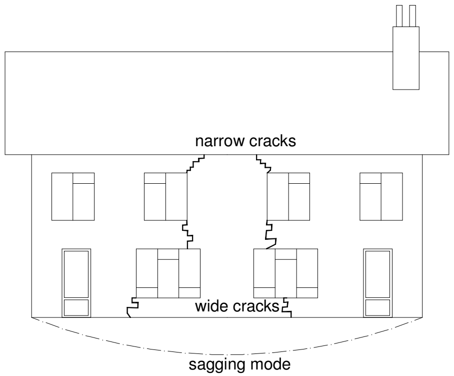


Fig. 3-15: Typical crack patterns associated with sagging of the building centrally (adapted from ref: 2).

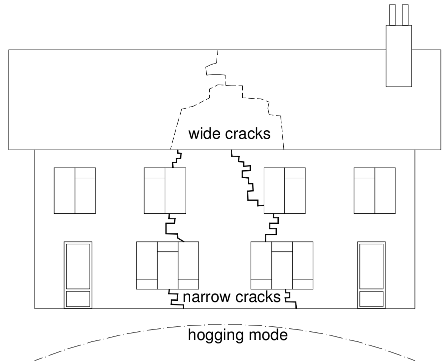


Fig. 3-16: Typical crack patterns associated with hogging of the building centrally (adapted from ref: 2).

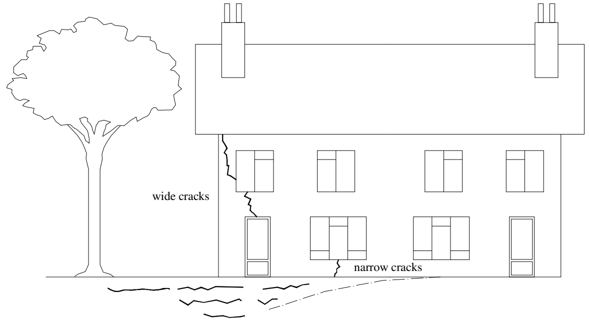


Fig. 3-17: Typical crack patterns associated with settlement at one side of building (adapted from ref: 2) .

7 Spalling

A spall is a fragment detached from a larger concrete mass. Spalling can occur from as a result of external loads or pressure produced by the expansion of corroded reinforcement.

Fig. 3-18: Spalling due to expansion of corroded reinforcement.

Fig. 3-19: Similar type of spalling at base of column due to corrosion of reinforcement.

Fig. 3-20: Severe spalling at beam soffit due to corrosion of reinforcement.

8 Exposed reinforcement

Corrosion is the deterioration of reinforcement by electrolysis. The products of the corrosion process have a volume much larger than the original steel. This volume increase generates high internal pressure which causes cracking, delamination (debonding) and eventually spalling of the concrete.

Exposed reinforcement is normally only visible after spalling of concrete. Inspection of this damage shall include inspection and recording of the severity of the corrosion as given in Appendix B.

Fig. 3-21: Corrosion of reinforcement causing concrete of the column to spall off.

Fig. 3-22: Severe corrosion of reinforcement with almost total loss of steel section.

12 Delamination

Delamination is a discontinuity of the concrete surface which is substantially separated but not completely detached from the concrete mass. Delamination can be checked by tapping the affected area and resulting in a hollow sound.

Fig. 3-23: Delamination at the side of the beam almost detached from the parent concrete.

Fig. 3-24: Delamination at the soffit of the beam is apparent by the bulge at the beam soffit.

14. Water leak

Sign of water leak is normally indicated by dampness, fungus or mould growth and sometimes formation of stalactites. Water leaks are the result of poor or failed waterproofing system, poor or porous concrete and cracking within the concrete.

Fig. 3-25: Dampness at the slab soffit is indicative of water leaks

Fig. 3-26: Stalactite formation at the slab soffit is indicative of water leaking through cracks in the concrete slab.

Fig. 3-26: Stalactite formation at slab soffit due to failed waterproofing membrane of the toilet above.

15 Tilt

Tilting of vertical members normally occurs due to uneven or differential settlement of the foundation. Usually the first indication of this problem is the change in geometry such as tilting of walls or columns; cracking of walls or glass window; and distortion of door or window frames leading to their sticking or jamming.

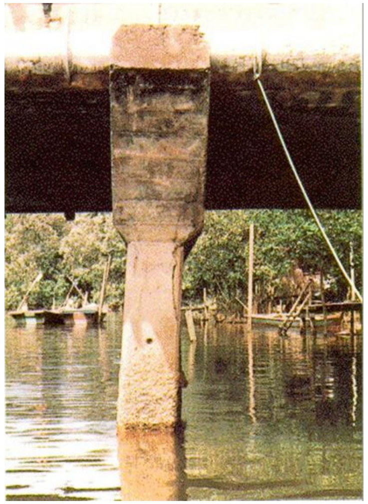


Fig. 3-27: A tilted column of a jetty

Fig. 3-28: A tilt can easily be checked by using a plumb line or a spirit level placed against the wall.

CHAPTER 4 –Inspection Procedure

4.1 Introduction

This chapter provides guidance to building inspectors on how the Building Conditions Inspection Report Form shall be filled in. The inspection involves the inspector identifying and quantifying the damages that were reported by the building owner or Client.

4.2 Preparatory Work

Prior to an inspection, the inspectors shall make a thorough preparation which includes gathering relevant information (desk study), identifying the suitable equipment and standard forms for recording, and confirmation of a referencing system.

During the desk study, the inspectors shall try to obtain as much information as possible about the buildings as listed below:

i. Construction records,

ii. All relevant drawings,

iii. Engineer and architect’s variation order instructions,

iv. Site/field observations,

v. Maintenance history,

vi. Previous and current use of building/room and loadings

All the equipment for conducting the inspection shall be gathered and in good working order. Similarly, they shall compile all the inspection report forms that will be needed for the inspection.

The inspectors shall also determine the referencing system for the building through discussion with his engineer.

HANDBOOK FOR CONDITIONS INSPECTION

4.3 Referencing System

A referencing system is necessary for making sure that personnel of the inspection and maintenance team will have a common understanding in identifying the locations in the buildings with problems.

The referencing system is based on a clock placed centrally in the plan of a building with the 12:00 o’ clock position referring to the wall facing the inspector as he enters a building or a room. Subsequently, the right, rear and left wall shall be referenced as 3:00, 6:00 and 9:00 o’ clock positions respectively i.e. following the clock orientation. Each floor of a building shall be identified as ‘level’ with Level 0 defined as the level where the main access is situated. Basement floor (if there is) shall bear a name with negative number.

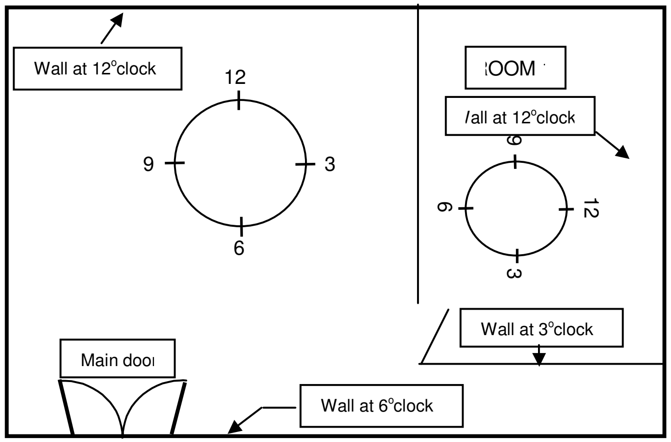


Fig. 4-1: Example of referencing system

Fig. 4-1 shows an example of a referencing system for a building and its rooms. The building components that the inspector faces as he enters a building or room shall be taken as 12^0clock position. The reason for adopting this system is that buildings could be in all sorts of shapes such as rectangle, octagon, hexagon etc or having several blocks interconnecting one another. In such cases the inspector may loose his orientation as he was conducting his inspection.

4.4 Inspection Equipment

The building maintenance unit at the district shall be equipped with proper inspection equipment. Listed below is a basic list of equipment required.

Table 4-1: List of equipment and purpose

No.	Equipment	Functions
1	5m measuring tapes	For measuring short dimensions
2	50m measuring tapes	For measuring longer dimension
3	Plumbob	For measuring degree of tilting
4	Crack Scale	For measuring surface crack width
5	Spirit levels	For measuring degree of tilting
6	Camera	For taking photographs
7	Blackboard, chalk and duster	For identification while taking photographs.
8	Clipboard	For filling up forms
9	Writing paper	For drawing sketches
10	Markers, chalk, pens and pencils	For marking and writing
11	Ladder	For accessing to a height of 3m.

12	Binoculars	For viewing locations where there is no access
13	Tapping hammer	For tapping the concrete surface in order to determine the soundness of the structure
14	Flashlights	For lighting dark areas

4.5 Conditions Inspection

The following notes explain how the Building Condition Inspection Report Form (JKR/BuI/1-06) shall be filled in as the inspector inspects a building. It follows the order of the report form given in Appendix A. A completed report form is given in Appendix C for reference.

Report form Page 1:

JKR/BuI/1-06

BUILDING CONDITIONS INSPECTION FORM

1.0 BUILDING DATA

1.1	Bldg Name:	Sek. Men. Dato' Sulaiman	1.4	Age:	30 years
1.2	Address:	13, Jalan Osman,	1.5	No. of floor:	3
		Mersing, Johor	1.6	Finishes:	Plaster/~~brickwork/tiles/cladding/others~~
			1.7	Roof:	Pitched/~~flat~~
			1.8	Environment	Coastal/~~interior/urban/rural~~
1.3	Bldg Owner:	Kementerian Pelajaran Johor			

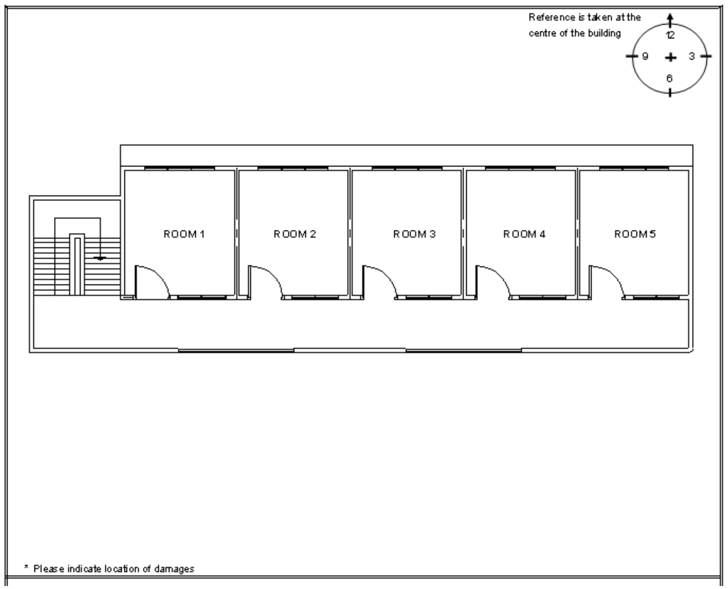
Upon arriving at a building site, the inspector is required to first enter the above information about the building. The information in the inspection form includes the following:

- Building name
- Building address
- Building owner
- Building age
- Number of floor
- Building finishes

- Building roof type and
- Building environmental exposure.

The next step, require the inspector to sketch a plan of the building in the space given in a box under Item 2.0. Preferably, construction drawings in A3 size of the buildings are attached with the report. The inspector shall indicate in the sketch/drawing the locations of the damage.

2.0 SKETCH PLAN OF BUILDING (Attach Layout Plan if available)



The bottom part of the report form shall be filled by the inspector at the end of an inspection. He is required to fill in the following information in order to complete his reporting.

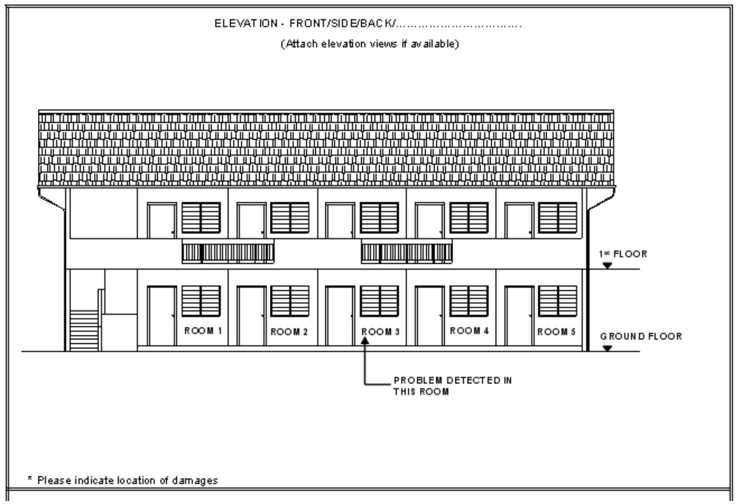
- Write down important comments that his engineer should know.
- Recommend whether the problems can be handled at the District or State JKR by ticking either ‘Required’ or ‘Not Required’.
- Write down the total number of pages in the report.

- Write down his name.
- Write down his designation.
- Write down the district he is attached to.
- Write down the date of inspection, and finally
- Sign at the designated area.

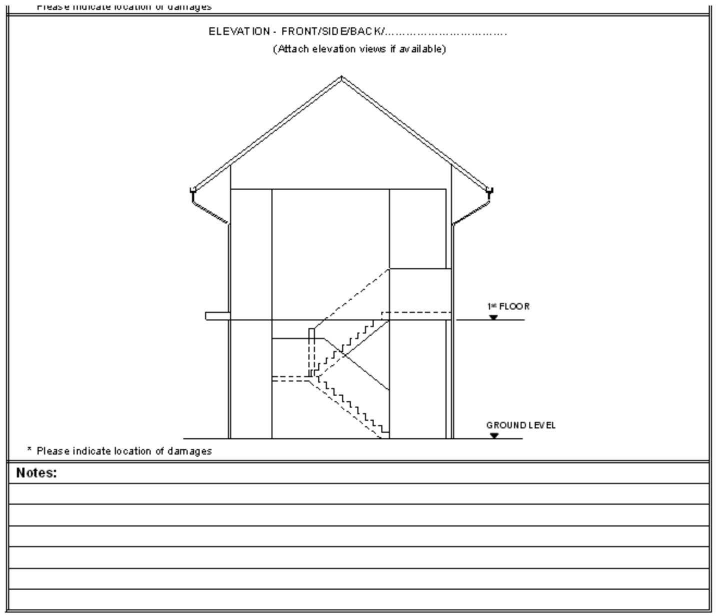
Inspector's Comment:			
i. Spalling at the beam and slab is quite severe as exposed reinforcement is badly corroded.			
ii. Settlement at the apron is more than 100mm and has caused wide cracks at the apron			
Confirmatory Inspection:	[✓] Required [ ] Not Required	No. of Pages:	4
Name of Inspector:	Ahmad Bin Busu	Position:	Senior Technician
Signature	Ahmad Busu	District:	Mersing
		Inspection Date:	15/10/2006

Report form Page 2:

On Page 2, the inspector is required to sketch the elevation of the building and indicate the location(s) of problem area(s). The inspector could also attach the elevation drawings to the report.



At the bottom of the page the inspector shall make notes of any important information.



Conditions inspection checklist

The main part of the inspection is filling out the Building Conditions Inspection Checklist as shown below. It contains typical lists of problems in buildings in which the inspector has to look for. The problems are listed under different building components i.e. beam, column, slab, wall, staircase and apron.

The inspector must fill in the report forms as he inspects the building. One checklist shall be used for each area or room of the building he is inspecting. The checklist requires the inspector to tick the appropriate box as he encounters any damage and finally give a condition rating for that damage. He may need to

write a note in the ‘Remark’ column if he needs to emphasize on the damage.

BUILDING CONDITIONS INSPECTION - CHECKLIST

BLDG NAME: Sek. Men. Dato' Sulaiman, Mersing NAME OF INSPECTOR: Ahmad Bin Basa

BUILDING MEMBER		TYPE OF DAMAGE	CODE	DAMAGE ?		SEVERITY OF DAMAGE				QUANTITY AFFECTED	
Component	Material			Yes	No	Light	Medium	Severe	V.Severe	*	
[✓] BEAM	[✓] Concrete	Cracks - Intrinsic	6a		✓						--
		Cracks - corrosion induced	6b	✓							--
		Cracks - load induced	6c		✓			✓			--
		Cracks - settlement	6d		✓						--
		Delamination	12	✓				✓		A	600mm2
		Spalling	7	✓				✓		A	900mm2
		Corrosion of Reinforcement	8	✓			✓				--
[✓] COLUMN	[✓] Concrete	Cracks - Intrinsic	6a		✓						--
		Cracks - corrosion induced	6b	✓							--
		Cracks - load induced	6c		✓			✓			--
		Cracks - settlement	6d		✓						--
		Delamination	12	✓				✓		A	500mm2
		Spalling	7	✓			✓			A	400mm2
		Corrosion of Reinforcement	8	✓			✓				--
		Tilt	15								-
[✓] FLOOR SLAB	[✓] Concrete	Cracks - Intrinsic	6a		✓						--
		Cracks - corrosion induced	6b		✓						--
		Cracks - load induced	6c		✓						--
		Cracks - settlement	6d		✓						--
		Cracks - settlement	6d		✓						
		Delamination	12		✓					A	
		Spalling	7		✓					A	
		Corrosion of Reinforcement	8		✓						--

FLOOR: Ground Floor ROOM: 3 DATE: 15 / 10 / 06

REMARKS	PHOTO NUMBER	RATING OF DAMAGE	RATING OF MEMBER
		1	4
		1	
	1	3	
		1	
	2	3	
	3	4	
		3	
		1	3
		1	
	4	3	
		1	
	5	3	
	6	3	
		3	
If detected rating = 4		1	
		1	1
		1	
		1	
		1	
		1	
		1	
		1	
		1	

At the *top* of the *checklist,* the inspector needs to enter the following information i.e. the *building's name, inspector's name*, the *level* and the *room* he is inspecting and the *date* of inspection.

Then he shall proceed with filling in the checklist - from the left column to the right column:

In Column 1 (for Building Member) of the checklist, all the main building components are listed. It consists of *two* sub columns - one for *building components* and the other *material types*.

In Column 2 (Types of Damages), all the common damage that may trigger complaints or request for inspection are listed. As the inspector is conducting his inspection, he shall go through the list. He shall then tick whether he detects any damage by ticking the boxes under Column 4 (Damage? – Yes/No).

The inspector shall refer to the code numbers given in Column 3 (Code) if he needs explanation on the type of damage he is checking. Description on each damage code is given in Chapter 3 of this Handbook.

As a next step, the inspector shall identify the severity of damage given in Column 5 (Severity of Damage). The severity of the damage is classified as *light, medium, severe* and *very severe*. The inspector shall refer to *Appendix B* (Classification of Severity of Damage) of the handbook for guidance in arriving at the severity level for each type of damage.

Having established the severity of damage, the inspector is also able to obtain a condition rating of the damage from Appendix B. He shall record the rating of damage in Column 9 (Rating of Damage). The condition rating of the damage is given in a numerical scale of 1 to 5 with 1 representing ‘as-new’ condition and 5 representing ‘dangerous’ condition. The detail description for each damage rating is given in the table below.

Table 4-2: Damage condition rating (Adapted from Ref. no.5)

Rating	Description
1	No damage found and no maintenance required.
2	Damage detected and it is necessary to record the condition for observation purposes.
3	Damage detected is slightly critical and thus it is necessary to implement routine maintenance work.
4	Damage detected is critical and in large part and thus it is necessary to implement repair work or to conduct a detail inspection to determine whether any rehabilitation works are required.
5	Being heavily and critically damaged, possibly affecting the safety of the building, it is necessary to implement an emergency temporary repair work immediately or rehabilitation work without any delay after evacuating the occupants and cordoning off the area.

If necessary, the inspector shall write notes to describe the damage detected in the box given in Column 7 (Remarks). He shall also supplement his report with photographs which should be properly labelled and record them in Column 8.

After obtaining the rating of damage in Column 9, the inspector shall proceed to inspect other types of damage. After completing the inspection of a particular component, he shall record down the worst rating of the member in Column 10 by selecting the worst rating of damage in Column 9.

The inspector shall then proceed to inspect other component in the building/room following the steps mentioned above.

Finally, he shall complete the bottom part of Page 1 of the inspection report form following the explanation given under section 'Report form Page 1'.

At this juncture, the inspector has to decide whether the problems he just inspected can be rectified at the district level or requires further inspection from State JKR. If he is undecided, he shall discuss the matter with his building or District engineer.

CHAPTER 5 – Recommendations

5.1 Decision Making

After completion of the inspection, the inspector shall discuss with his engineer the findings of his inspection. From here decision shall be made whether the problems can be remedied at the District or need further inspection by the State JKR. As a general rule of thumb, non- structural problems shall be handled by District JKR and structural problems shall be reported shall to State JKR.

5.2 Basic Remedies to Non-Structural Problems

This section is intended to assist District JKR in dealing with simple remedial works for problems that are non-structural. (Adapted from Ref. 3)

Table 5-1: Basic remedies to non-structural problems

Defects	SPALLING OF RENDERING ON BRICKWORK
Location	External walls
Symptoms	Render splits away from the undercoat, sometimes taking with it a thin film of undercoat.
Remedies	If only small areas are affected, remove loose material, roughen undercoat and apply rendering. If necessary, treat the undercoat with a bonding agent before applying the top coat. Where extensive, the whole rendering may have to be replaced.

Defects	RANDOM CRACKING OF RENDERING ON BRICKWORK
Location	External walls
Symptoms	Crack forming no define pattern are seen. When tapped, the rendering in the vicinity of the crack may sound hollow whilst in some places, it may have fallen away.
Remedies	1 Repair cracks in brickwork if cracks resulted directly from cracks in the brickwork and then make good the rendering. 2 Extensive cracking and break away is difficult to make good without total re-rendering which is costly. To prevent water penetration and chemical attack, weather cladding such as tile hanging or ship-lap boarding is necessary. Painting with a cement-based paint or a textured coating may help.
Defects	BLISTERING OF PAINTWORK TO RENDERING AND CLADDING
Location	External walls
Symptoms	Blisters or bubbles forming early in the life of buildings may contain water. In older buildings the paint film may have cracked and peeled back. Efflorescent salts may also be seen.
Remedies	Eliminate all sources of water and redecorate.
Defects	SHRINKAGE CRACKS
Location	Walls and ceilings
Symptoms	Cracks which may be long, but only fine, and

HANDBOOK FOR CONDITIONS INSPECTION

	which appear as new work dries out i.e. during the first year after completion. They will usually appear at the junctions of floors/walls/ceilings, and may also outline the joints of plasterboard sheets or blockwork background.
Remedies	Allow time for the drying out process to be completed (about six months), fill the cracks and redecorate.
Defects	FULL/THICKNESS OF PLASTER LOOSE
Location	Walls and ceilings
Symptoms	The full thickness of plaster has come away from the background; loose areas sound hollow when tapped, and cracks will often be evident. The plaster may bulge or sag, and in extreme cases, will have fallen away.
Remedies	1 Remove all plaster from affected area, and clean off loose material; replaster using bonding-type base coat. If necessary roughen the concrete surface and/or use a bonding agent.
Defects	TOP COAT OF PLASTER LOOSE
Location	Walls and ceilings
Symptoms	The top coat of plaster has come away from the base coat, so that it sounds hollow if tapped; cracking and bulging is probably evident. It may have come away altogether exposing the undercoat plaster.
Remedies	Remove the entire top coat from the affected area, and replaster using an appropriate material. If the undercoat is unsound it too must be renewed.
Defects	PITTING OF PLASTERWORK
Location	Internal wall finishes

Symptoms	Small conical shaped craters occur in the surface of the plaster generally with a small piece of foreign material in the base.
Remedies	Remove foreign material from craters and make good with appropriate filling material.
Defects	DISCOLOURED AND BLISTERED DECORATION
Location	Internal wall finishes
Symptoms	Discolouration may be localized or general. It is usually permanent but may be temporary where dampness is present. Some discolouration is distinctly brown, pink, purple or black. It is particularly important when decorations are discoloured around air bricks. Blistering is usually localized and occurs on paint films or wallpapers. The blisters are quite often temporary and when broken may create sticky yellowish runs.
Remedies	1 Remedy dampness (penetrating, condensation, rising damp). Redecorate after allowing the wall to dry out thoroughly. Note that surfaces with mould growth may need fungicide treatment. Ascertain the use of the room bearing in mind the toxic nature of such treatments. 2 Where necessary old flues can be lined or bottom ceiling plates can be fitted to flue liners.
Defects	PEELING AND FLAKING PAINTWORK
Location	Applied decoration
Symptoms	Paint peeling off in large sheets, or flaking off in smaller pieces, sometimes from new

	surfaces but more usually from old, redecorated surfaces.
Remedies	1 Remove all loose paint and efflorescence to a firmly adhering, sound, clean surface, rub down any gloss paint surfaces, and redecorate with suitable materials. Remedy any cause of dampness and allow surface to dry out before redecorate
Defects	SEMI-PERMANENT DAMP
Location	Walls at or near ground level
Symptoms	Semi-permanent damp can be seen on wall surfaces from ground level up to approximately 750 mm (30 in) or even higher in severe cases. Decorations may be damp, blistered and discoloured or dried out and pushed off the wall by a salt deposit. There may be rot in floor and skirting boards adjacent to the defective wall.
Remedies	1 Provide damp-proof course. 2 Remove soil or material bridging damp-proof course. 3 Repair or replace damp-proof course. Additional work such as renewal of plaster or skirting board will be required. Advise the tenant accordingly.
Defects	DAMP SOLID WALL ASSOCIATED WITH RAIN
Location	Solid walls
Symptoms	Decorated internal surfaces of solid external walls subject to driving rain are visibly damp shortly after the rain. When the wall dries out stains can be seen and there might also be evidence of surface staining or mould growth under the surface.

Remedies	1 Render walls to resist rain penetration. Alternatively, materials such as ship-lap boarding should be considered. In less serious cases, apply water repellent. Repoint defective mortar joints. 2 Repair or replace defective guttering or down-pipes.
Defects	PATCHY DAMP NOT ASSOCIATED WITH RAIN
Location	Walls
Symptoms	Patchy damp areas appear initially on internal plasterwork, accompanied by peeling wall paper, discolouration or, after a longer period, surface stains or mould growth.
Remedies	1 Check for possible back-fall in overflow pipe. Check operation of ball valve, adjust, rewasher, renew as necessary. 2 Replace embedded pipes and redecorate. 3 Remove plaster in defective area and replace with new covering fixed on battens, redecorate. 4 Repair or replace waste pipes, dry out area and redecorate. 5 Replace rising main, or cover, insulate and redecorate area over buried pipe.
Defects	GENERAL DAMP NOT ASSOCIATED WITH RAIN
Location	Walls
Symptoms	General damp or patches of damp occur particularly in kitchens and cold bathroom. Moisture beads appear on the surface of dense materials (e.g. concrete lintels above windows) and there may be signs of rusted

	metal fittings and in extreme cases, mould growth.
Remedies	1 Improve ventilation, provide a more adequate or better distribution of heat such as background heating, or provide a higher standard of insulation on areas subject to condensation. 2 Consider providing a vapour barrier over affected areas.
Defects	DAMP WALL OR CEILING
Location	Internally below parapets
Symptoms	Damp is visible on the internal plaster of the upper parts of external walls / ceiling junction and it may then spread downwards. It will be particularly pronounced after heavy rain.
Remedies	1 Take down and rebuild the parapet in order to add or replaced a damp-proof course. If the damp-proof course exists already, check that water running off it does not run into well. 2 Repair defective parapet/roof junction. 3 Repair or clear gutter or outlet.
Defects	PATCHY WHITE DEPOSITS
Location	External and internal surfaces
Symptoms	Efflorescence may appear as a white fluffy powdery substance or a hard glassy deposit on external or internal surfaces. It is often seen on brickwork during the first dry period building but may occur regularly after prolonged rain. Internally, it may be found under paint and wall paper or on plaster which has not been decorated. Lime bloom is a white stain on external

	surfaces near to concrete, e.g. brickwork at the ends of concrete sills.
Remedies	1 Brush powdery substance off the surface. If it returns, it is because the surface has not fully dried out or, because the source damp is still present. The damp must therefore be cured. 2 Lime bloom can only be removed by washing with diluted acid. Strict safety precautions are necessary.
Defects	ALGAE, LICHEN AND MOSSES
Location	External surfaces
Symptoms	Various coloured growths may be seen on the external surfaces of building, particularly in moist conditions.
Remedies	If necessary, remove growth with toxic wash followed by wire brushing, and remedy dampness. Ensure gutters do not become blocked.
Defects	MOULD GROWTH
Location	Internal decoration and paintwork
Symptoms	Grey, green, black or brown spots or patches are seen on internal decorations which may have spread to form a furry layer. Paintwork may show signs of pink or purple discolouration. Affected areas are likely to be damp.
Remedies	Remedy dampness, strip off decorations, treat surface with fungicide (poisonous material), and redecorate. If not possible to eliminate the damp completely, materials for decoration should be resistant to mould growth.

REFERENCES

1. BRE Digest 361 (1991) Why Do Buildings Crack. Building Research Establishment.
2. Building Research Establishment. (1996) Cracking in Buildings. RB and LL Bonshor. Construction Research Communications Ltd.
3. National Building Agency. (1979) Common Building Defects – Diagnosis and Remedy. The Construction Press.
4. Ransom, W.H. (1987) Building Failures-Diagnose and Avoidance. E. & F.N. Spon
5. Road Engineering Association of Malaysia. A Guide for Bridge Inspection. REAM
6. Transport and Road Research Laboratory. (1988) Overseas Road Note 7, Vol 2, Bridge Inspector's Handbook. Transport and Road Research Laboratory.
7. Unit Jambatan, JKR (1995) Annual Bridge Inspection Manual – Quick Inspection Guideline.
8. MacGregor, James, Reinforced Concrete Mechanics and Design, 3rd Ed., Prentice Hall, 1997.