

Construction Industry Council & Labour Department

Webinar on Reinforcement Cage Stability

Mark McGleenon 5 December 2022







http://www.twforum.org.hk

About the TWf

Established in 2017, the HK-TWf advocates to raise standards and awareness of proper and good practice in Temporary Works. Our membership is open to any HK company or individual who shares the same belief and we produce guidance for all practitioners in Hong Kong to consider for their use.



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Introduction

- Current Issues
- Design & Construction Considerations
- Roles & Responsibilities
- Checklist Examples
- Accident Cases

There is nothing new here – the TWf has presented on this topic since 2017 and remains an area of concern!



Current Issues

Current Issues

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Design & Construction Considerations

Role & Responsibility

Checklist

Accident Cases

Limited Publications...



Temporary Works FORUM (HK-TWf) 香港-臨時工程論壇

http://www.twforum.org.hk



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Current Issues

Design & Construction Considerations

Role & Responsibility

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Accident Cases

Recognition, Design for Interim Stage & Implement Procedures



http://www.twforum.org.hk





Publication
Published by HK Temporary Works Forum (HK-TWf)
Published October 2018



Current Issues

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Plan for Temporary Works & Responsibility of Subcontractors

		Programme Week Number											
Activity		-4	11	5	9	13	17	21	25	29	33	37	41
Site Infrastructure		+											
Foundations and External Services		+	1										
Framework, Floors and Walls	+												
Cladding - Masonry and Roof		+	SITE										
Services - M & E and Lifts		+	NOL										
Bathrooms and Pipework	+		STAR										
Internal Finishes and Decoration			1	+									14
Fit-out and Furnishings			114										
Commissioning and Snagging			i										





Current Issues

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Design & Construction Considerations

Role & Responsibility

Checklist

Accident Cases

Unclear Responsibility...





Lateral Support

- When needed?
- Any checking?
- Whose responsibility?





Current Issues

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Accident Cases

Unclear Responsibility...



Lifting

- Lifting points?
- Any checking?
- Whose responsibility?





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Accident Cases

Unclear Responsibility...



Chairs

- How many?
- Size / Details?
- Whose responsibility?





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Unclear Responsibility...



Bracing

- How many?
- Size / details?
- Whose responsibility?







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Unclear Responsibility...



Ties

- How many?
- Type / fixing details?
- Whose responsibility?





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Design & Construction Considerations



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Typical Failure Modes during Lifting

- 1) Instability of the crane / lifting plant
- 2) Failure of lifting equipment (strops, chains, bars, shackles, lifting eyes, etc)
- 3) Lifting points ripping off the cage
- 4) Axial buckling due to compression caused by inclined chains/strops
- 5) Bending failure with scissor action at laps or excessive deflection of cages
- 6) Laps and splices give way



Suitably designed reinforcement arrangement around lifting points



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Typical Failure Modes during Erection





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Typical Process

- 1) Permanent Works Design
- 2) Fabrication
- 3) Pre-lift Operation
- 4) Lift Operation
- 5) Temporary Condition
- 6) Permanent Condition





Current Issues

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Design & Construction Considerations

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Select External Support	Select Internal Members		Change Manag
 Temporary support Guy wire / cable Anchor block Loading assessment Structural analysis 			
	Figure 5.1 – (Left) Adjustable pole of rebar column cage us	there e. (Right)Typical external bracing sing struts and anchor blocks	
	Reinforcing cage Footing and reinforce not shown for clarity	chor ckhor ckk ement	Additional U- par spacers ied to porizontal lacer pars applicable to

Accident Cases



		Select Internal Members		
Current Issues		 Tie wire Clamp Splice Mat 		
Design &		BracingOther additional measures		OT OT O
Construction				Plate 5.2 – Example of clamps
Considerations			and the second	
Role & Responsibility	Detail 1 - Ti Ti Beaver Ti0 Chair (see note below)		g of baser utilits this region Chir Ta Ta Hut fe to lab min for Chir Ta Chir Ta Chir Ta Chir Ta Chir Ta Chir Ta Chir Ta Chir	Plate 5.3 – Example of welded splice detail
Responsionity	Tis T16 Tis T16 Tis T16 Bearer T40	Chair (see note below)		
Checklist	meter tao 0.50000000464 6.5500mm this 0. Tao 0.10000000464 0.5500mm this 0.000mm this 0.0000mm this 0.00000000000000000000000000000000000	Slash tie Hairpin		
Accident Cases	Baver Tio vie Char Detail 1	The wave Figure 5.5 - Typical tie patterns		

Plate 5.1 – (Left) Single slash tie (Right) Double slash tie



Current Issues

Design & Construction *Considerations*

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Role & Responsibility

Checklist

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Cage Installation

Rigging & Lifting

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	Select External Support	Select Internal Members	Change Management
Current Issues			Communication
			Information flow
Design & Construction Considerations	\mathcal{P}	?	
Role & Responsibility			
Checklist		2	



Role & Responsibility



Current Issues

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Personnel

- 1) Permanent Works Designer
- 2) Temporary Works Designer
- 3) Temporary Works Coordinator
- 4) Construction Manager
- 5) Project Manager
- 6) Fabricator
- 7) Foreman

Role

- R-Responsible
- or
- C Consulting role

All need to take responsibility.... Not just Sub-Con

	^o ermanent Works De Employer Representa	Femporary Works De TWD)	Femporary Works Co TWC)	Construction Manage epresentative				
Process		- -		0 2				Responsible Individual Name
Fabrication	-	-	<u> </u>					
constructability	к	C		C				
Design of longitudinal pick-up bars		С		C		R		
Design of internal bracing	C	С				R		
Tying requirements				С		R		
Quality Control, Inspection, Verification				R				
Design/Spec of lift points		R		С				
Ensure temporary works design is in place			R					
Pre-Lift Operations								
Site management	<u> </u>			R				
Health and safety plan					R		С	
Crane access/staging				R	С			
Lift plan		С		R	С			
Design of temporary support		R		С	С			
Ensure lifting plan is in place			R					
Lift Operations								
Preparation/equipment				R	С		С	
verification								
Issue permit to lift			R					
Pick/lift				C			R	
Move				С			R	
Stabilize/place		С		С			R	
Reinspect the integrity of cage and carry out remedial works		С		С		С	R	
		С		С			R	
Temporary Condition								
Initial support		С		С			R	
Formation installation							R	
Safety engineering				R				
Pour management							R	
Issue permit to pour concrete			R					
Formwork removal							R	
Support removal		С		С			R	
Permanent Condition								
Inspection	R			C				
Acceptance	R			C				



Checklist - Examples



Current Issues

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Design & Construction Considerations

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- 1) Permanent Works Design Checklist
- 2) Fabrication Checklist
- 3) Pre-lift and Lift Checklist (before erection)
- 4) Pre-lift and Lift Checklist (on the day of erection)
- 5) Temporary Condition Checklist
- 6) Permanent Condition Checklist

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CHECKLIST	H
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Current Issues

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Pe	rmanent Works Design Checklist		
lte	ms	Y/N	Remarks
1)	Have design alternatives been considered that allow for smaller cages or allowances for segmental construction?		
2)	Was additional longitudinal reinforcement or stronger ties considered to promote greater stiffness for the cage's temporary condition?		
3)	Has the fabricator or rebar sub-contractor detailed internal braces and will they provide sufficient stiffness?		
4)	Was a constructability review done in consultation with the general contractor to identify potential conflicts with staging lifting, or supporting of the cage on site?		
Co	mpleted by: Sign	ned off	by Temporary Works Designer

- Avoid Conservative Design
- Reduced Rebar = Reduced Risk
- Consider Stability when detailing

Table 6.2 – Fabrication Checklist

ns	Y/N	Remarks
Tie wire connections shall use not smaller than 15 SWG tie wire made of soft annealed black steel with a minimum ultimate strength of 275MPa.		
At least four vertical bars forming a square shall be tied at every intersection with at least a double tie wire connection. The strength of these connections shall be adequate for cage pick-up.		
At a maximum of 2.4m increments, template hoops shall be tied at every intersection with at least a wrap and saddle tie wire connection.		
At least 20% of the remaining reinforcement intersections shall be tied with single tie wire connections. The connections shall be staggered from adjacent connections.		
Check that a proper temporary works design (e.g. weight of cage, overturning FOS, adequate base support for the cage,) is in place.		
Check that proper shop drawings showing details of reinforcement cage and supporting system (e.g. props, guy wires, chairs, bracing, U-bolts, connection at base, etc.) according the temporary works design is in place.		
Types, frequency and spacing of ties comply with the design; ties are correctly tensioned; sufficient twist projects from the tie		
Shape codes, size, orientation, position, spacing, dimension and layering of bars are correct; no unauthorised cutting and heating of bars has taken place; bars are bent using correct formers		
Splices have lap length and appropriate ties; appropriate lap stagger has been employed		
Cage has retained the design shape; reinforcement has not been kinked or bent out of shape; physical dimensions of the cage comply with the design		
Mechanical couplers are fully engaged and tightened; mechanical grips / connectors are installed in accordance with manufactures guidelines and are tightened to the correct torque; welding is carried out by an appropriately skilled welder to an approved procedure; welds comply with the design and are of appropriate length and size		
	Tie wire connections shall use not smaller than 15 SWG tie wire made of soft annealed black steel with a minimum ultimate strength of 275MPa. At least four vertical bars forming a square shall be tied at every intersection with at least a double tie wire connection. The strength of these connections shall be adequate for cage pick-up. At a maximum of 2.4m increments, template hoops shall be tied at every intersection with at least a wrap and saddle tie wire connection. At least 20% of the remaining reinforcement intersections shall be tied with single tie wire connections. The connections shall be staggered from adjacent connections. Check that a proper temporary works design (e.g. weight of cage, overturning FOS, adequate base support for the cage,) is in place. Check that proper shop drawings showing details of reinforcement cage and supporting system (e.g. props, guy wires, chairs, bracing, U-bolts, connection at base, etc.) according the temporary works design is in place. Types, frequency and spacing of ties comply with the design; ties are correctly tensioned; sufficient twist projects from the tie Shape codes, size, orientation, position, spacing, dimension and layering of bars are correct; no unauthorised cutting and heating of bars has taken place; bars are bent using correct formers Splices have lap length and appropriate ties; appropriate lap stagger has been employed Cage has retained the design shape; reinforcement has not been kinked or bent out of shape; physical dimensions of the cage comply with the design Mechanical couplers are fully engaged and tightened; mechanical grips / connectors are installed in accordance with manufactures guidelines and are tightened to the correct torque; welding is carried out by an appropriately skilled welder to an approved procedure; welds comply with the design and are of appropriate	Tie wire connections shall use not smaller than 15 SWG tie wire made of soft annealed black steel with a minimum ultimate strength of 275MPa. At least four vertical bars forming a square shall be tied at every intersection with at least a double tie wire connection. The strength of these connections shall be adequate for cage pick-up. At a maximum of 2.4m increments, template hoops shall be tied at every intersection with at least a wrap and saddle tie wire connection. At least 20% of the remaining reinforcement intersections shall be tied with single tie wire connections. The connections shall be staggered from adjacent connections. Check that a proper temporary works design (e.g. weight of cage, overturning FOS, adequate base support for the cage,) is in place. Check that proper shop drawings showing details of reinforcement cage and supporting system (e.g. props, guy wires, chairs, bracing, U-bolts, connection at base, etc.) according the temporary works design is in place. Types, frequency and spacing of ties comply with the design; ties are correctly tensioned; sufficient twist projects from the tie Shape codes, size, orientation, position, spacing, dimension and layering of bars are correct; no unauthorised cutting and heating of bars has taken place; bars are bent using correct formers Splices have lap length and appropriate ties; appropriate lap stagger has been employed Cage has retained the design shape; reinforcement has not been kinked or bent out of shape; physical dimensions of the cage comply with the design Mechanical couplers are fully engaged and tightened; mechanical grips / connectors are installed in accordance with manufactures guidelines and are tightened to the correct torque; welding is carried out by an appropriately skilled welder to an approved procedure; welds comply with the design and are of appropriate



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Design & Construction Considerations

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Accident Cases

Table 6.4 – Pre-lift and Lift Checklist (Before Erection

	-lift and Lift Checklist (Before Erection)		
Ite	ms	Y/N	Remarks
1)	Have you completed a Job Hazard Analysis?	1	
2)	Establish who will direct the crane operator; determine if hand signals or radio will be used to communicate.		
3)	Have all guy lines & braces (if required) been installed on cage prior to erection? Ensure guy lines & braces are easily accessible without the need to climb the cage. Check cable clamps.		
4)	Notify contractor and other subs that all guying & bracing only to be removed by Harris personnel. Have guying and or bracing check off sheet on site.		
5)	Foreman to inspect bracing and guy lines to ensue materials are good.		
6)	Is fall protection required? If so, is there a procedure in place? Are there other methods available (i.e. man baskets, genie lifts, scaffolding, etc?)		
7)	Are there other trades working in the vicinity of the erection & if so, ensure that adequate warning is given of the impending hazard. When picking cage all personnel need to stay at least the length of the cage away, except for the signal person & persons on the tag lines. Foreman to check each cable clamp.		
8)	Rig cage to ensure all hoisting rigging can be removed without the need to climb the cage. Alternately, climb only after a foreman confirms that all guying & bracing is complete and cage is safe to disconnect rigging.		
9)	Establish if tag lines need to be used and if so, that the person holding them has been properly trained. (Where to go in case of emergency.)		
10)	If cage is going to be secured to formwork, ensure that the formwork has been designed to support the additional weight of the cage. In addition, review formwork details to ensure that there are means of tying off the cage.		
11)	Inspect the cage to be flown to ensure no loose verts or untied pieces; Ensure cage is adequately tied to carry weight of other ties or verts.		
12)	Ensure no one stands below cage as its being flown throughout the job site.		
13)	Make good all dowels in preparation of accepting cage.		
14)	Have a tail-gate meeting with the crew responsible for rigging, including crane operator and contractor's rigger (if applicable) to review all actions and hazards just prior to erection operation commences, include a written sign off sheet.		
15)	Does everyone on the erection crew agree with the plan? If YES -		

16) Install all chairs or spacers on the cage prior to erection to p the need to climb the cage or formwork after the cage is ere Alternately, climb only after a foreman confirms that all guy bracing is complete and cage is safe to disconnect rigging.	revent ected. ing &
17) All guying & bracing to be adequately identified with reflecti tape or flags at appropriate heights to make highly visible to operators, mobile equipment operators and personnel.	ive crane
18) Tie all the right angles on the bottom of footing solid.	
19) Check any impact on adjacent slope, retaining wall, tempora platform, scaffolding, etc.	ary
20) Ensure working condition is appropriate (e.g. even ground, f ground, etc.), and necessary measures are implemented to e safe execution of reinforcement cage fixing.	îrm ensure
21) Ensure stockpiling location of reinforcement cage is in strict accordance with the loading key plan	
22) Ensure all workers are fully briefed about all key requirement	its.
23) Check and ensure the reinforcement cage complies with the defined lifting and supporting requirements.	
24) Check and ensure that the reinforcement cage complies with requirements related to the supporting system (e.g. props, g wires, chairs, bracing, U-bolts, connection at base, etc.)	h all guy
25) Check if there is any slab starters or other bars (corbels, etc., projecting horizontally resulting in eccentric loads, and ensu they are sufficient to take the load of the reinforcement cag concreting.) re e and
26) Any modifications that are necessary to enable bars to be fix have been approved by the TWD and Bar Fixing Foreman.	(ed
27) Any distress to the cages or failures of ties should be reported the TWC.	ed to
28) When lifting, a lift plan is in place and complied with.	1
29) Appropriate lifting beams, shackles and slings are used in accordance with the lift plan and temporary works design.	
30) A post lift inspection should be carried out, with any loose of tie wires replaced.	r failed
Completed by:	Signed off by Temporary Works Designer

Recognise Stability & Issue Design Brief

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Current Issues

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Table 6.5 - Pre-lift and Lift Checklist (On the Day of Erection) Pre-lift and Lift Checklist (On the Day of Erection) Y/N Remarks Items 1) Know the setup of the cranes 2) Know the effect the hoist has on the crane 3) Know where to look when hoisting, watch for the unknown - all eyes should be watching. Watch for side loading 4) 5) Watch for non-plumb vertical lines. 6) Watch for line and sheave problems. Watch and understand boom deflections 8) Watch for cage trip problems. 9) Special rigging training by a wire rope manufacturer, 3 classes on jobsite training required. 10) On heavy picks a person should be watching the back side of the crane to make sure it is not raising up. 11) If we are using the contractor's spreader bar, make sure it is certified before using 12) Check and ensure that the base of the cage is fixed to a structure which is stable and sufficient to hold the cage. 13) Check and ensure that measures are implemented to prevent any loose rebar from hitting people nearby during lifting, stockpiling and fixing Completed by: Signed off by Temporary Works

Designer

 Include Rebar Stability as pert of Pre-lift Checks



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Y/N Remarks Items bar as determined during pre- if cage right angles secured to termined during pre-planning? 1) Have t manned documents ane until all bracing and j or guy reman to inspect cage and/or heck list for all cages set in a urn in copy of check off to 2) Has all for da 3) Have t affects ber trades not to touch bracing Completed	Temporary Condition Checklist					Permanen	
bar as determined during pre- if cage right angles secured to etermined during pre-planning? 1) Have the manned document and until all bracing and j or guy reman to inspect cage and/or heck list for all cages set in a urn in copy of check off to 2) Has all for da 3) Have the affect 3) Have the affect ber trades not to touch bracing 0 ber trades not to touch	Items		Y/N	Remarks	lte	ms	
ane until all bracing and j or guy 2) Has all for da irreman to inspect cage and/or 3) Have t heck list for all cages set in a 3) Have t urn in copy of check off to affect her trades not to touch bracing Completed braces. Completed	 Tie off bottom of cage to dowel rebar as determ planning. Alternately, are bottom of cage right a bottom mat or support frame as determined dur 	ined during pre- ngles secured to ring pre-planning?			1)	Have t manne docun	
heck list for all cages set in a urn in copy of check off to affect braces. Completed	 Ensure cage is not released from crane until all b lines (if applicable) are installed. Foreman to insp 	pracing and j or guy pect cage and/or			2)	Has al for da	
her trades not to touch bracing Complete	bracing or guying and complete a check list for a day and record on sign off sheet. Turn in copy of general contractor if required.	ll cages set in a check off to			3)	Have t affect	
braces. Completed	 Instruct General Contractor and other trades not and/or guy lines. 	t to touch bracing					
	4) Foreman to check cable clamps or braces.				Coi	mpleted	
	 3) Instruct General Contractor and other trades no and/or guy lines. 4) Foreman to check cable clamps or braces. 	t to touch bracing				Со	

able 6.7 – Permanent Condition Checklist

Items	ר	//N	Remarks
 Have the guys or temporary supports been moved or removed manner inconsistent with the temporary support plan? If so, document. 	d in a		
2) Has all rigging and support hardware been removed and inspe for damage?	cted		
3) Have the support systems of adjacent or nearby cages been affected by the removal of this cages supports?			
Completed by:	Signad	off	Tomporany Works
Completed by:	Signed	offi	Designer

- *Recognise the need for Interim Stage Support*
- *'Rule of Thumb' guidance (ie Max. free standing height) for frontline workers*



Accident Cases



Current Issues

Design & Construction

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Accident Cases

- November 2022
- Hong Kong
- 1 killed



The Construction Industry Council (CIC) would like to deliver this safety message for your attention. It would be much appreciated if you could distribute the message below to your fellow members, relevant personnel or other industry stakeholders where appropriate. Thank you very much.

As a Contractor / Subcontractor / Employer:

- 1. Provide and maintain a safe system of work to ensure the safety of workers / employees engaged in reinforcement bar structure works; 2. Appoint a competent person to conduct task-specific risk assessments to identify all potential hazards associated with the work, taking into account the nature of work and the working environment;
- 3. Formulate appropriate safe work methods and procedures detailing the proper sequences of work for the erection / alteration of reinforcement structure;
- 4. Appoint a professional engineer with adequate gualifications, competence and experience to design the reinforcement structure that is in conformity with established standards, and of sufficient load bearing capacity and stability; and
- 5. Provide workers/employees involved with adequate information, instruction and training to ensure that they are familiar with the safe work procedures and safety measures

As Frontline Supervisor / Worker:

- 1. Ensure that the reinforcement bar structure is erected/altered strictly in accordance with the design drawings, specification and method statement: 2. Ensure that no additional loading to be added to the reinforcement bar
- structure: 3. Ensure that all site personnel and workers involved are competent by virtue of their knowledge, skills and experience with regard to their respective duties;
- 4. Provide suitable and adequate safe means of access to and egress from ever place of work.

As a Safety Practitioner:

- 1. Assist the competent person to conduct task-specific risk assessment with respect to the operation and actual site conditions. Then assist the employer to formulate safe working methods and procedures in compliance with the Works in accordance with the design drawings. requirements of safety legislation and guidelines; and
- 2. Develop and implement an effective proactive inspection program to ensure that safety measures are strictly followed and recort any non-compliances.

The above only listed out key points of safety, for more information please make reference to (Construction sites (Safety) Regulations) , the (Safe System of Work) and (5 Steps to Risk Assessment) issued by the Labour Department











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Accident Cases

- July 2020
- Hong Kong
- 1 killed, 6 injured





Current Issues

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Accident Cases

- **2015**
- Hong Kong
- 4 injured







Current Issues

Design &

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Accident Cases

- Dec 2014
- Tsinghua High School, China
- 10 killed, 4 injured

清华附中工地底板钢筋倒塌示意图



张小阔 词北





Current Issues

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Design & Construction Considerations

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Accident Cases

- July 2011
- Hong Kong
- Two killed





Current Issues

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Design & Construction Considerations

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Accident Cases

Many others...















Current Issues

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Conclusion

- Be aware of rebar cage instability as Temporary Works
- Implement Temporary Works Management Procedures & Checklists
- Identify responsible Person before Starting Works
- Don't just reply on Supply Chain experience



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	Green the		aloutus - Working Groups - News Technol Activity - Rubuondnis Galler Links -
		ed 200 en Hoad Transformer Tra	Description of the product of the
		ant Roberto	LIFELINES AND ANCHORAGE SYSTEMS Fails from heights (FM) are one of the largest causes of anions and fatal injury in the Keng Kong construction. Thus it is assential that robust measures are implemented to protect workers from the rais of fatiling. This guide has been developed in obset to help employers and workers who are working at heights to have a better understanding of the importance of the correct installation of anchorage points, (Meines and semporary edge protection as a means of fail prevention. STATUS OF THE PUBLICATION: DRAFT VI Any comment on the document should be provided to Bill Robinste on or before 30 November 2021. Only corporate members will be able to download the draft document.
	12 Jac	ent 2020 Anny Shu Pati an anno	REINFORCEMENT CAGE STABILITY Reinforcement cage is one of the most common features on construction projects. However, the assessment of the'r temporary stability during Inforg and prior to concerting has limited gudance and is unata commonly dash with by custom and practice. They have bare howen to collegae and cause stor dash and hilyur. They advance nore is unitation to highlight the key issues, and to give specific assistance to those specifying. managing, dasigning and installing reinforcement cages. STATUS OF THE PUBLICATION: FINAL VIA



General

Sequence Sections

http://www.twforum.org.hk

12August 2020 TEMPORARY STEEL PLATFORMS - A GUIDE TO GOOD PRACTICE

Temporary state justiones (TSP2) are common to construction sites that require plant movement and/or storage on slopes, effaitore construction or data extractions with space constrains. At present, there is a lack of local codes of pacta or data phy plantmass specifically, addressing TSP2 and, as a consequence, plantman of longing datapase of homes are being used that on constraints there reacted in which and code that

DOWNLOAD THE DOCUMENT 🚣





