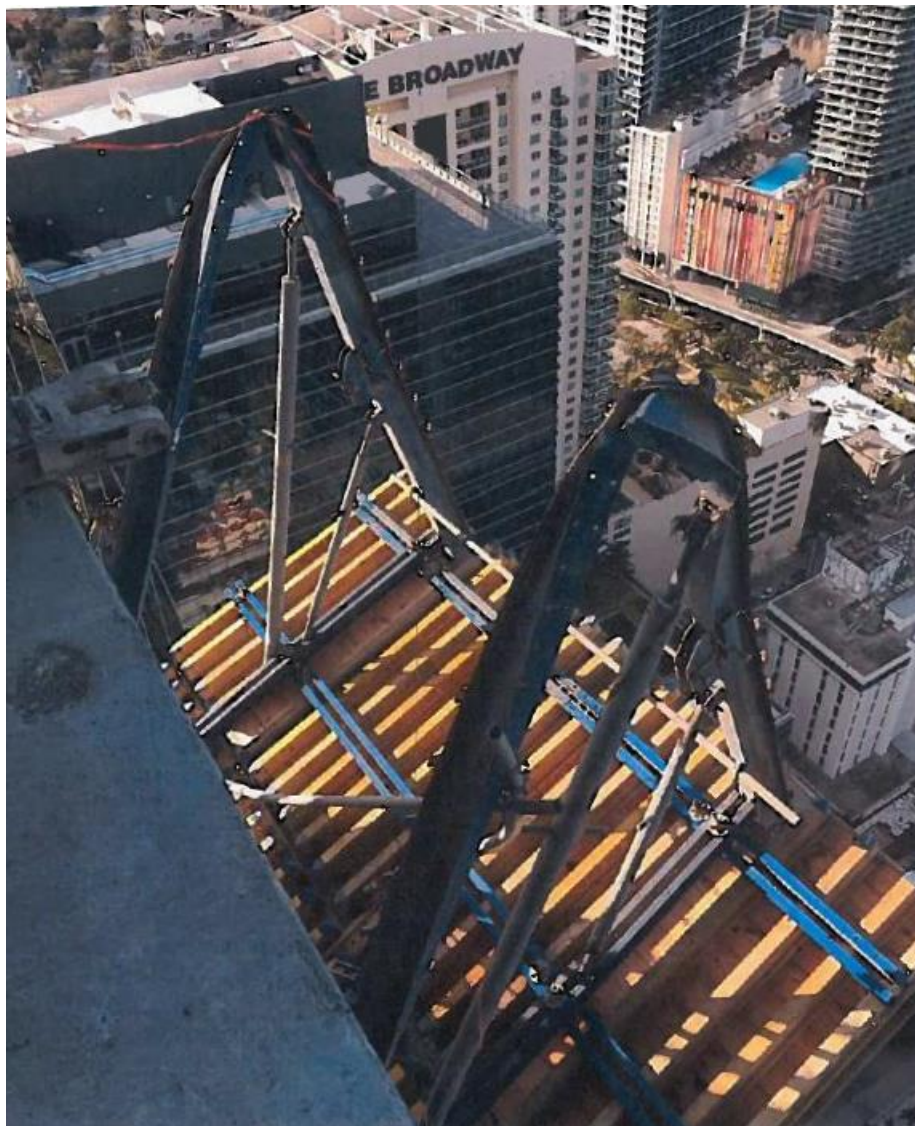


Investigation of the October 19, 2016, Collapse of Two Scaffold Platforms during Climbing in Miami, Florida

U.S. Department of Labor
Occupational Safety and Health Administration
Directorate of Construction

April 2017



Report

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1. The Background

On the afternoon of October 19, 2016, two scaffolds, known as Doka Xclimb 60 loading platforms, collapsed and several pieces of debris from the platform fell to the ground from the 48th floor of a high-rise residential building under construction in downtown Miami. The loading platform was used for moving materials, formwork tables, and equipment in and out of the building. The incident occurred at the Echo building project while a pair of scaffolds was being repositioned from the 47th floor to the 48th floor of the building. Four people were injured and a fifth person, a by-stander, died of a heart attack while fleeing the debris. Two construction employees working at the site were injured while trying to get away from the falling materials; one employee suffered a head injury and the other suffered an injury to his knee cap. One of the other injured was a driver in a car, on the adjacent street, that was crushed by the falling materials. The debris from the incident forced authorities to close nearby streets to traffic.

The OSHA Regional Administrator, Region IV in Atlanta, requested the Directorate of Construction (DOC), OSHA National Office, in Washington, D.C., to provide engineering assistance in its investigation of the incident. One structural engineer from DOC visited the site to examine the failed loading platforms and to obtain construction documents. A safety compliance officer from the Fort Lauderdale Area Office was also present during the visit.

2. Project

The project was a luxury condo building approximately 50-stories high, named “Echo Brickell” at 1451 Brickell Avenue, Miami, Fla., see figure 1. The building has approximately 180 units with an average floor area of 1,800 square feet per unit. The site was in downtown Miami, adjacent to a state highway with multiple commercial buildings nearby. The building’s developer was Property Markets Group (PMG) of New York, N.Y. John Moriarty & Associates (JMA) of Hollywood, Fla. was the General Contractor (GC) for the project, and there were several sub-contractors working for the GC. The shell contractor responsible for the failed scaffold platforms was CECO concrete construction, LLC of Tampa, Fla.



Fig. 1 – Location plan (from google maps)

CECO was using Doka Xclimb 60 loading platforms for moving materials, formwork tables and equipment in and out of the building. Doka USA (Doka) of Little Ferry, N.J. was the manufacturer of the scaffolds. Doka prepared the engineering drawings of the scaffold, which was signed by a Florida professional engineer. Doka furnished the parts, all engineering data, drawings, specifications and training for assembling and operation of the scaffold. CECO had the Xclimb 60 loading platforms on the north and south side of the building. Typical drawing indicated four types of scaffold; A, B, C and D. The width of the scaffold varied, but all of them cantilevered 16 feet outward from the building. Type A was 17 feet wide; type B was 18 feet wide; types C and D were approximately 12 feet wide. The scaffolds were essentially supported by two columns called vertical profile beams, 32 feet tall, anchored to the building structural floors with slab shoes. The slab shoe is fastened to the vertical profile beam and to the concrete floor. For the platform details, see figures 2 to 7. In working condition, each vertical profile beam must be connected to the building floor slab by slab shoe at a minimum of three floor levels. There are two methods available to raise the scaffold to the next higher floor, either by hydraulic jacks or by a crane. During hydraulic climbing, each vertical profile beam must remain connected at a minimum of two floor levels below the destination floor. The vertical profile beam has hooks spaced 12 inches apart on the building side.

During hydraulic positioning, the slab shoe pin is released from the vertical profile beam and the platform is jacked up until the pin locks with the next hook. This is repeated until the platform reaches the desired floor level and then the platform is secured by slab shoes. The platforms were

in use at the site for more than a year and CECO had been raising these platforms using the hydraulic system (except between floors 29 to 33, where positioning by crane was required by the manufacturer).

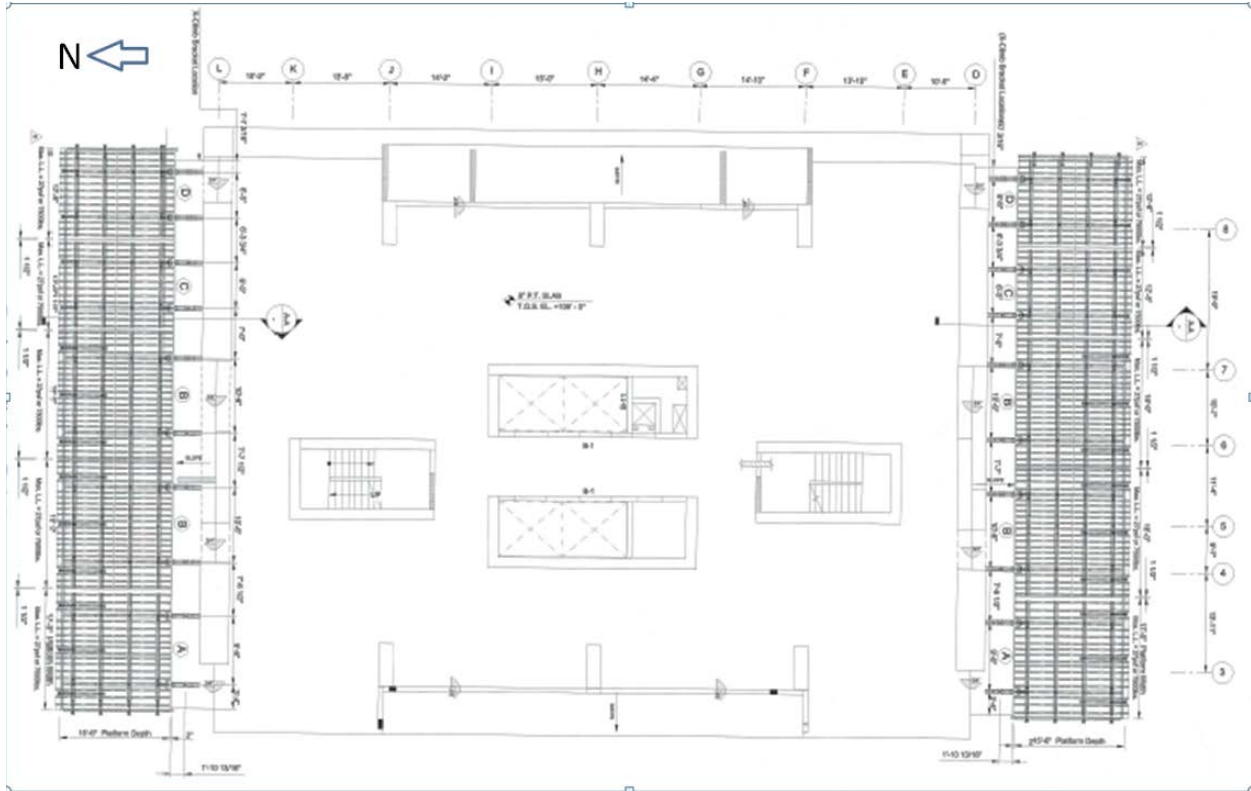


Fig. 2 – Plan of scaffolds on north and south sides (from sheet 1530)

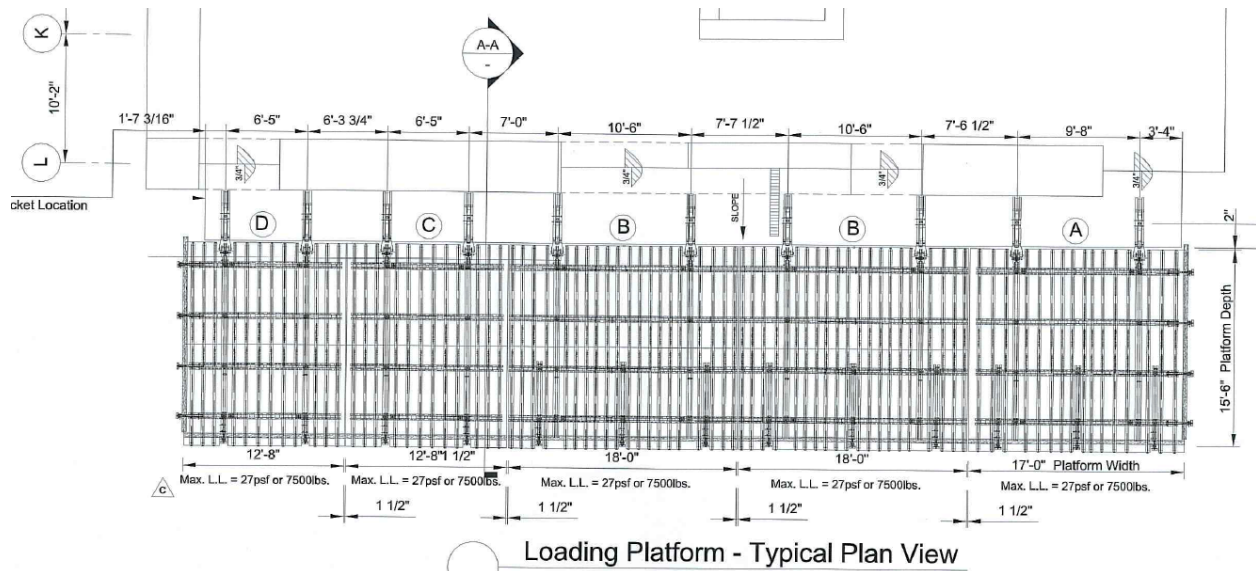


Fig. 3 – Plan of scaffolds on north side enlarged (from sheet 1530)

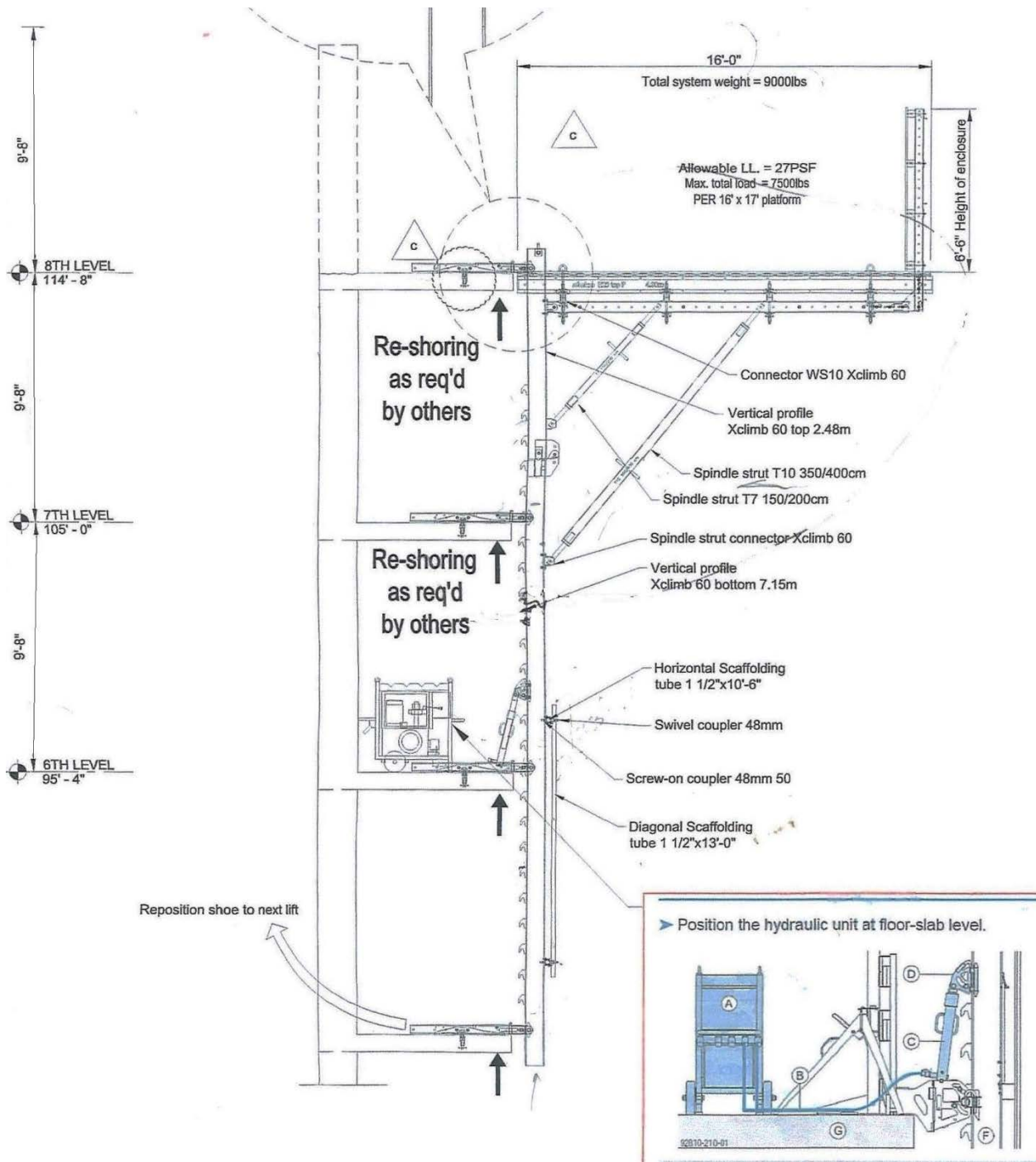


Fig. 4 – Typical section of the scaffold and hydraulic unit (from sheet 1530)

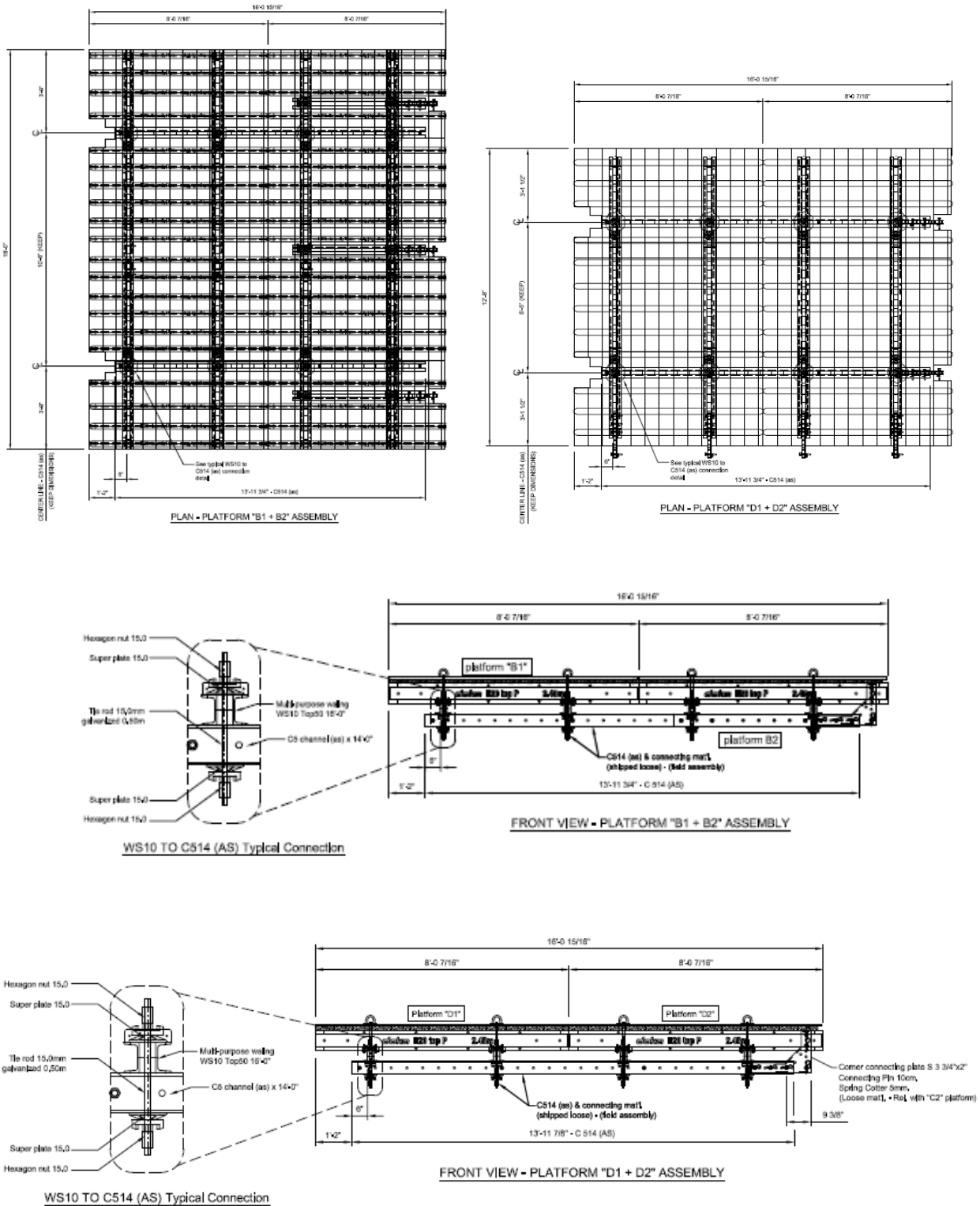


Fig. 5 – Scaffold details from manufacturer drawings (from sheet 3520 and sheet 3526)



Fig. 6 – Scaffold in stationary position



Fig. 7 – Scaffold in stationary position

3. The incident

On the day of the incident there were three platforms being raised on the north side of the building. Among these three, two of them were the larger B platform 18'x16' in size (B1+B1 combination), and the third was a smaller D platform 18'x12' in size (D1+D1 combination); see figure 5. All three of them were being raised from the 47th floor to the 48th floor. The distance between the two larger platforms was about 7 feet. CECO placed approximately 16 purlins, approximately 20'-6" long, spanning the two larger platforms (see figure 8), and also placed plywood over these purlins; therefore CECO converted this space between the larger platforms (about 7 feet x 16 feet) into a deck. By this arrangement CECO was carrying the purlins between the floors and was also using the space to carry the materials while climbing the platforms. The smaller D platform (18'x 12') was independent, separated from the larger platform by about 7 feet and was on the east of the larger platforms. The arrangement of the three north side scaffolds at the site is shown below in figure 8 and the two scaffold platforms that were involved in the incident are identified.

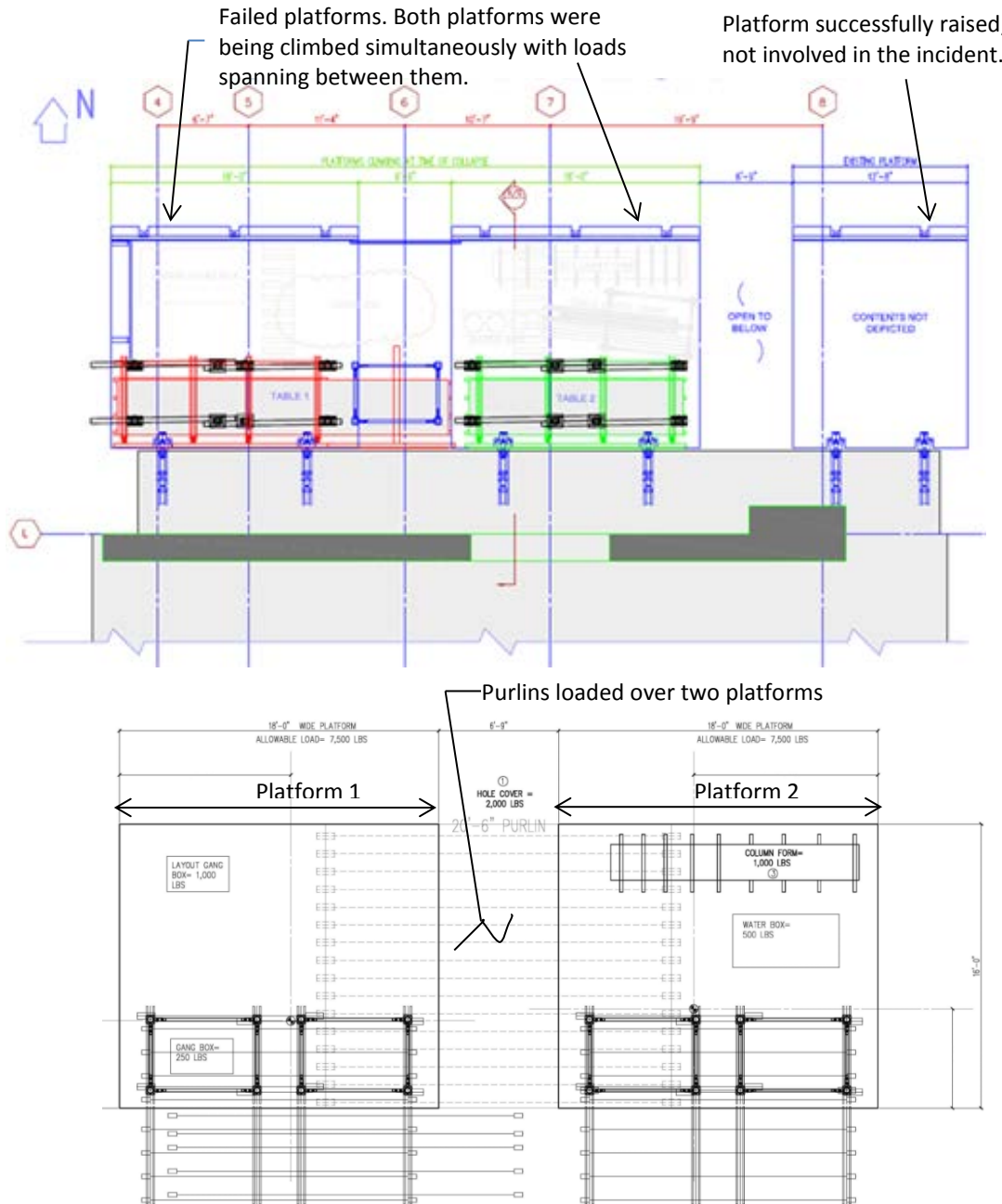


Fig. 8 – Platforms plan view with materials (prepared by CECO)

Before the incident, the crew had successfully raised the smaller platform by hydraulic climbing to the 48th floor and the platform was in a stationary position. As required, it was anchored with the slab shoes at three locations at the 46th, 47th and 48th floors. CECO then decided to hydraulically climb the larger two scaffolds together, with materials spanning between them, in a synchronized manner. The hydraulic jacks were positioned on the 46th floor. During hydraulic climbing, both scaffolds failed and the scaffolds rotated almost 135 degrees (see figures 9 to 12).

Both scaffolds had already climbed more than 13 feet and the scaffolds were almost at the 48th floor, but did not quite reach to the 48th floor. The materials on the two scaffolds, weighing approximately 13,000 pounds, fell to the ground, see figures 13 and 14. The failed scaffolds (see figures 15 and 16) were brought down later with a crane.



Taken from CBS Miami
Fig. 9 – Failed platforms

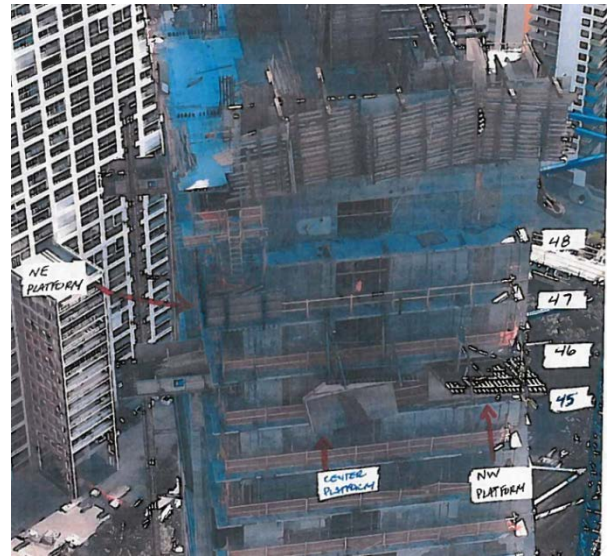


Fig. 10 – Failed platforms

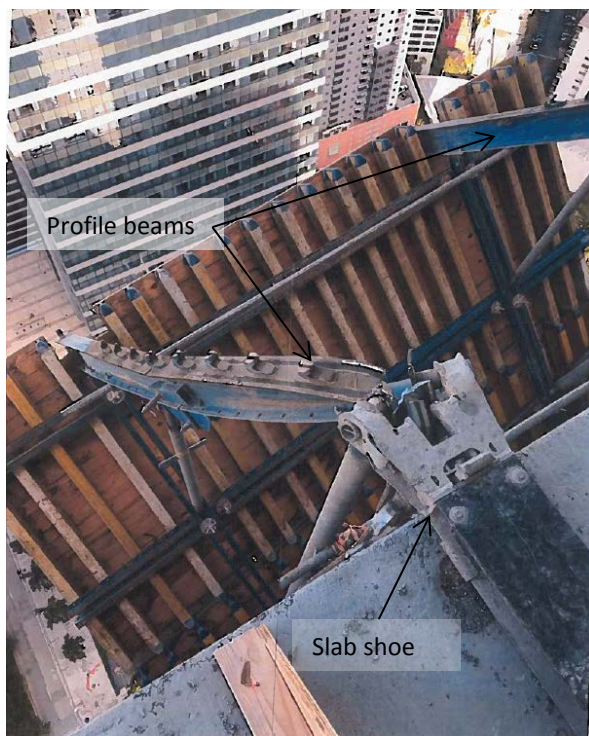


Fig. 11 – Failed platform

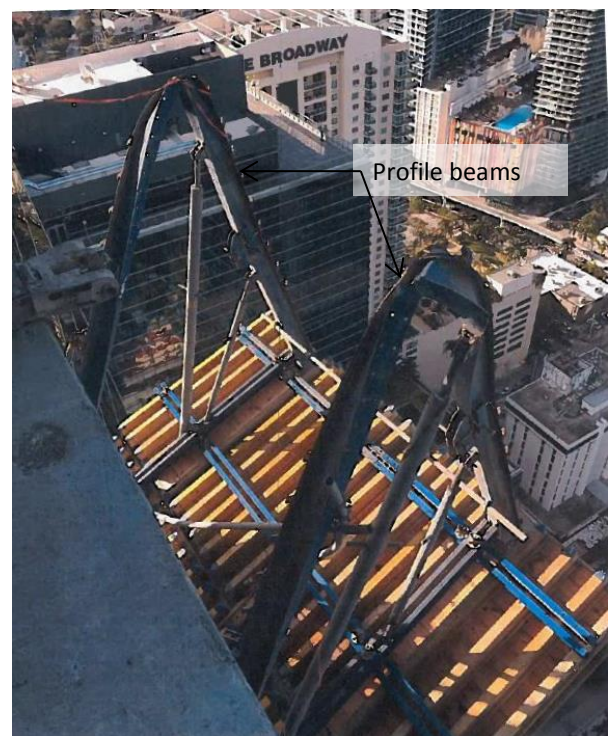


Fig. 12 – Failed platform



Fig. 13 – Materials on the ground

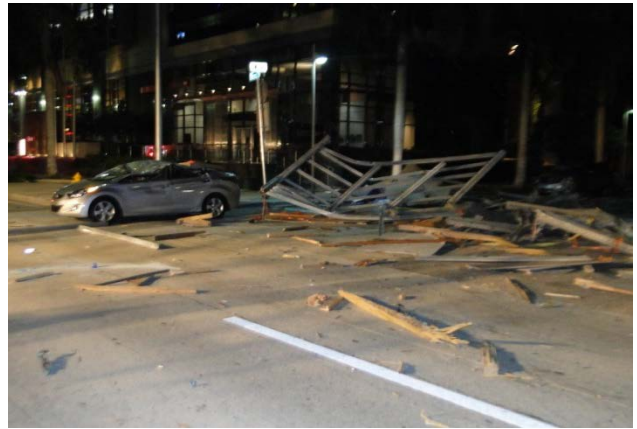


Fig. 14 – Materials on the ground

Profile beams



Fig. 15 – One of the failed platforms



Fig. 16 – Other failed platform

4. Discussion

The discussion will be limited to the two type B scaffolds on the north side that failed. Type B was 18 feet wide and the scaffold cantilevered 16 feet outward from the building. The scaffolds were supported by two vertical profile beams, 32 feet tall, anchored to the building structural floors with slab shoes. Doka, the manufacturer of the platforms, prepared the engineering drawings and Doka furnished CECO the components, all engineering data, drawings, specifications, and training for assembling and operation of the scaffold.

After the incident, the scaffold engineering details and manual of the platform under use were provided to OSHA by Doka. According to Doka, the work was started in 2015, and the applicable manual for the scaffold was “*Protection screen Xclimb 60 with Framed enclosure*”

Xbright,” 05/2012 version (see Appendix) which was provided to CECO project manager by Doka.

The drawing sheet 1530 of 4/21/2015 with latest revisions on 1/8/16 prepared by Doka (see figure 4 and appendix), indicated that the allowable live load on the platform was 27 psf. The height between the floors was shown by Doka as 9'-8". The drawing also indicated that “*X-climb 60 Loading Platform must be in MINIMUM 2 Slab shoes while climbing/repositioning*” and “*X-climb 60 Loading Platform must be in MINIMUM 3 Slab shoes in working condition.*”

After the incident, Doka provided the material list for the scaffold assembly, and it indicated that the weight of a type B scaffold was 8,183 pounds and the approximate center of gravity of the assembled scaffold was about 7'-2" from the edge of the vertical profile beam (see figure 17).

Platform	Size	WEIGHTS (lbs)				Total Wt.
		Deck	Side Screen	Back Screen	Climbing Rails	
A	17'x16'	4905	1064	891	1955	8815
B	18'x16'	5223	0	984	1976	8183

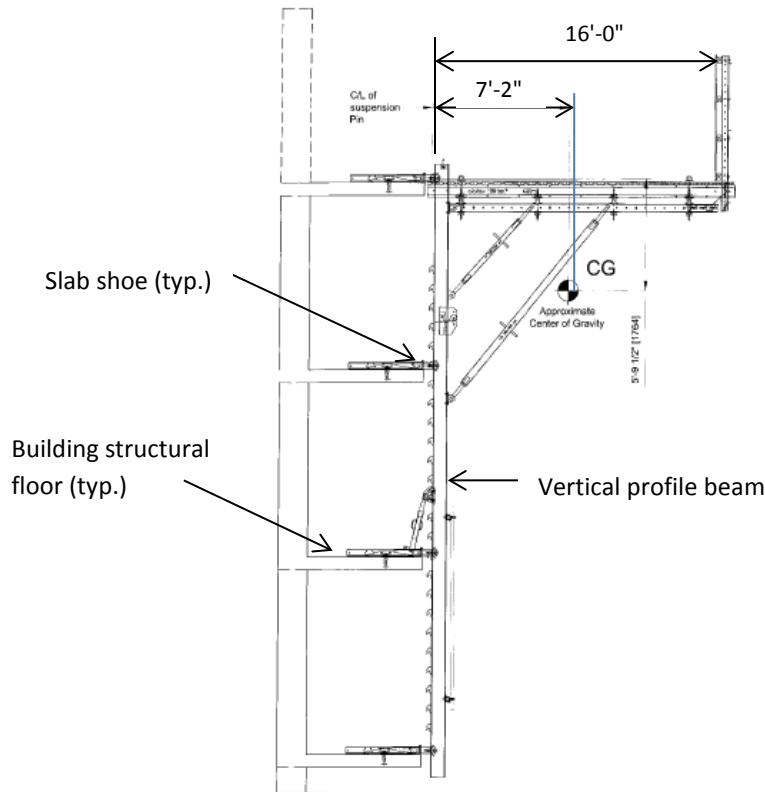


Fig. 17 – Self-weight of platform and CG obtained from manufacturer

For a type B platform, 18'x16', with an allowable load of 27 PSF, the maximum allowable live load in a stationary position was computed as 7,776 pounds ($18 \times 16 \times 27 = 7,776$ pounds).

Page 80 of the manual (see appendix) states that under Hydraulic repositioning *"No payload (service load) is allowed on the loading platform while it is being repositioned."* On further communication with Doka, Doka confirmed that *"The allowable working Live load is 7500 lbs. distributed as a uniform load of 27 psf while anchored in a stationary position. **During climbing the allowable load is the self-weight (dead weight) of the platforms only**"* (emphasis ours). In other words, during climbing, no load can be placed over the platforms, as it will compromise structural integrity.

After the incident, the collapsed platforms and fallen materials were moved to a yard in a nearby location. Before moving the materials, an inventory of the debris was prepared by CECO under the guidance of OSHA. From the material inventory, the two failed platforms together had a superimposed load of approximately 13,000 pounds while the platforms were being climbed by hydraulic repositioning (see figure 18 and appendix). This was a violation of the manufacturer's loading requirement and the contractor thereby violated OSHA regulations 29 CFR 1926.451(f)(1) *"Scaffolds and scaffold components shall not be loaded in excess of their maximum intended loads or rated capacities, whichever is less."* The scaffolds failed and the materials on the two platforms fell to the ground.

The wind gust speed on the day of the incident was obtained from the National Climatic Data Center for the airports in Miami. At the Miami International airport the gust wind speed at 29 feet above sea level was 24 mph. Although it was windy on the day of the incident, the wind was not a contributing factor to the failure.

The incident occurred during climbing and therefore structural analysis for the design condition was performed with a floor height of 9'-8" as shown in the drawing prepared by Doka. In addition, for the climbing condition, various floor heights and loading were considered. Wind was not considered in the analysis.

The critical elements for stability during climbing are the unsupported height of the platform, self-weight of the platform and the superimposed load over the platform, the location of the

superimposed loads on the platform, and the resisting capacity of the vertical profile beams together with platform components.

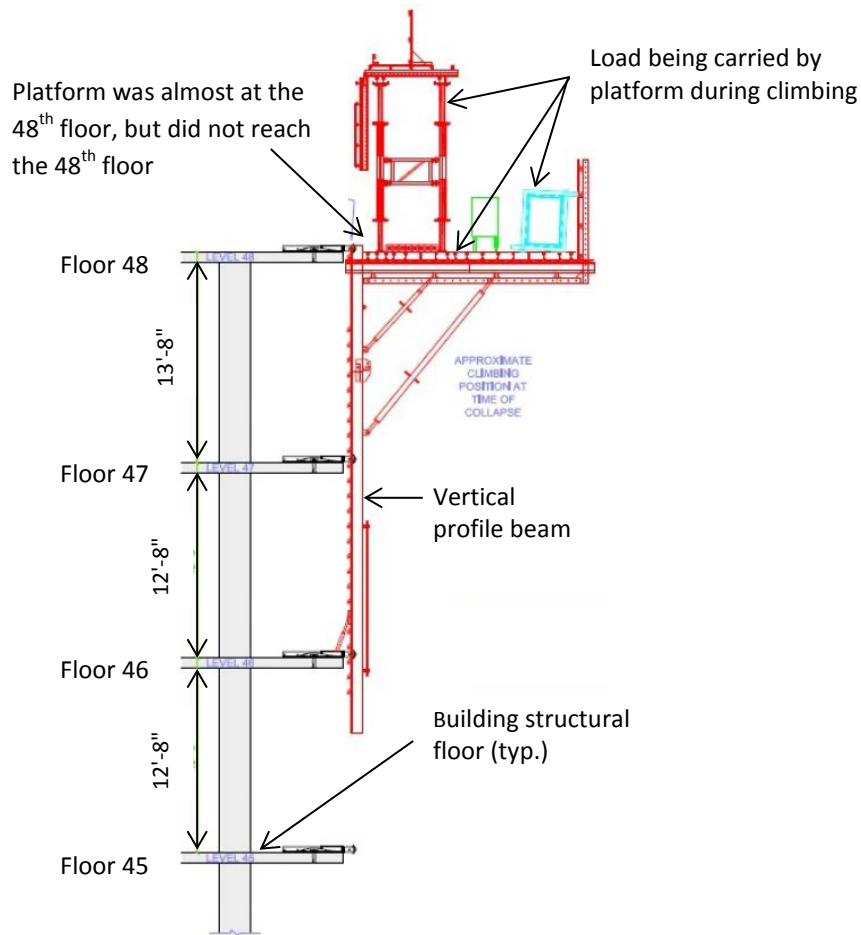


Fig. 18 – Depiction of the platform section loaded with material (provided by CECO)

For analysis purposes, the following weights were considered to act on a single platform (type B - 18'x16'):

- 1) Self-weight of the platform (type B - 18'x16') was taken as a point load of 8,183 lbs. acting at center of gravity of 7'-2" from the vertical profile beam.
- 2) The total superimposed load at the time of the incident (case 5 below) on each platform was assumed to be approximately 6,500 pounds (After the incident, the inventory of the materials indicated 13,000 pounds on two platforms. For analysis, 6,500 pounds was assumed on each platform), which consisted of:

- a) Formwork table's weight was modelled as a point load of 2,500 pounds acting at 4'-9" from the vertical profile beam.
- b) Column form and large gang box weight was modelled as a single point load of 1,200 lbs. acting at 13'-0" from the vertical profile beam.
- c) The purlins and additional materials accounted for the remaining weight of 2,800 lbs. To simplify the analysis, this weight was modelled as a uniformly distributed load of 175 psf. acting over 16 feet, the entire width of the platform.

The vertical profile beam was modelled as an I-beam with European shape IPE 220, 32 feet long, with a yield stress of 50 ksi. The bracings were assumed as pipe sections, 4" diameter for the lower one and 2" diameter for the upper one.

The purpose of the Structural Analysis was to examine the stability of the platform. The following cases were considered.

Case 1: Stationary position with platform at floor 8 and slab shoes connected to floor slabs at floors 5, 6, 7 and 8. Height between floors is 9'-8", as shown in drawing. Live load is 7,776 pounds (27 psf).

Case 2: Climbing condition with no live load. Height between floors is 9'-8", as shown in drawing. The platform is in climbing position with a vertical cantilever of 9'-8". Slab shoes connected to floor slabs at floors 5, 6 and 7.

Case 3: Stationary position with platform at level 8 and Slab shoes connected to floor slabs at floors 5, 6, 7 and 8. Height between floors is 9'-8", as shown in drawing. Live load 31,104 pounds (108 psf), 4 times the allowable load.

Case 4: Climbing condition with no live load. Platform is almost at floor 48 with a vertical cantilever height of 13'-8". Floor height between floors 46 and 47 is 12'-8" and height between floors 47 and 48 is 13'-8". Slab shoes connected to floor slabs in floors 46 and 47.

Case 5: This represents the climbing condition at the site at the time of the incident. Platform was climbing and almost reached floor 48. Floor height between floors 46 and

47 is 12'-8" and height between floors 47 and 48 is 13'-8". Platform is in climbing position with a vertical cantilever height of 13'-4". Slab shoes connected to floor slabs in floors 46 and 47. The live load was assumed to be 6,500 pounds with a combination of point loads and distributed load to simulate the actual condition at the time of the incident.

In all five cases, the loading on the platform was assumed to share equally between the two vertical profile beams.

From the results for cases 1, 2 and 4, the stresses in the scaffold were within the allowable limits. For case 3, the stresses in the scaffold were within the ultimate strength stress as required. For case 5, which simulates the actual condition, the scaffold components failed with D.L.+L.L. combination. The combined stresses in the vertical profile beam were greater than the ultimate strength stress, and the vertical profile beam was stressed beyond its capacity.

At the time of the incident, while hydraulically repositioning the X-climb 60 scaffolds, CECO was using the scaffolds to carry materials between the floors. OSHA regulation 29 CFR 1926.451(a)(1) requires that "Each scaffold and scaffold component shall be capable of supporting, without failure, its own weight and at least four times the maximum intended load applied or transmitted to it." In case 5 above, the structure failed with the applied load without any increase in the applied load as required by OSHA regulation. It is therefore obvious that if the applied load is increased to four times the live load, the structure won't satisfy the OSHA requirement. The scaffold loaded with materials as used by CECO therefore did not meet the OSHA regulation 29 CFR 1926.451(a)(1) during hydraulic positioning.

5. Conclusions

1. A pair of scaffolds, also known as X-Climb 60 Loading Platforms, suddenly collapsed while they were being simultaneously raised from the 47th to the 48th floor by two independent hydraulic means. The scaffolds had almost reached the 48th floor when the two platforms bent over and failed. The platforms were substantially loaded with approximately 6,500 pounds of materials each during the climb. During the climb, the structural performance of the scaffold is altered, significantly reducing the load-carrying capacity of the platform until it is structurally connected to the destination floor. After the incident, the manufacturer had stated that the platforms ought not to have been loaded during the climbing phase as per its manual, which stated that “*No payload (service load) is allowed on the loading platform while it is being repositioned*”. The incident resulted in multiple injuries to two employees and bystanders.
2. OSHA’s requirement of supporting the dead load and four times the intended load was violated by CECO while the scaffold was being raised with materials placed on it.
3. The loading of the platforms as discussed above was further exacerbated by the fact that the floor-to-floor height between 47th and 48th floor was 13’-8” significantly greater than 9’-8”, the height for which a typical detail was prepared by the manufacturer and provided to the contractor. The load on the platforms during climbing, coupled with the increased floor-to-floor height, overstressed the scaffolds, and resulted in the failure.
4. An additional anomaly was created when the contractor decided to climb both the scaffolds together in a synchronized manner with superimposed loads that also spanning both the platforms. The failures were therefore compounded.
5. The drawing showing hydraulic repositioning had a floor height of 9’-8”. The manufacturer had also prepared a drawing for raising the platform by a crane from floor 29 to 33 where hydraulic means was not feasible. CECO should have contacted the manufacturer for clarification and engineering support when the floor heights were higher than 9’-8”.
6. The wind was not a causal factor.

6. Appendix

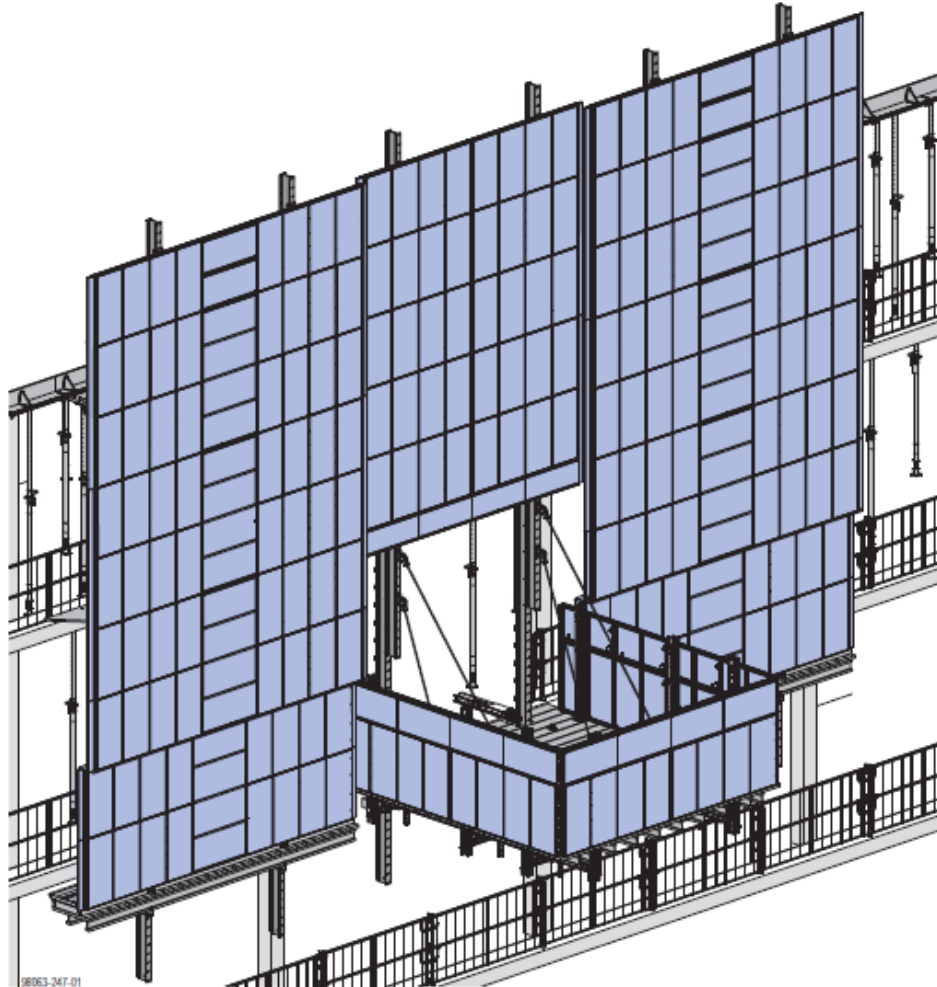
05/2012

User information

999806302 en-GB

Method statement

Protection screen Xclimb 60 with Framed enclosure Xbright



doka
The Formwork Experts

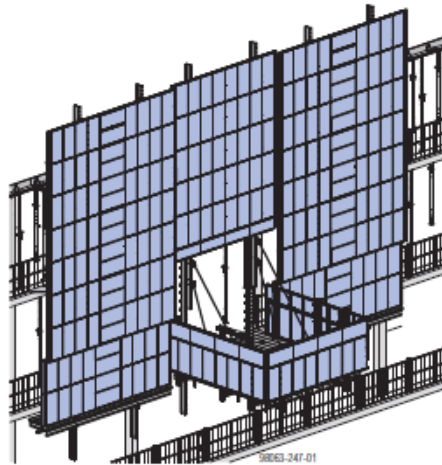
Manual coverage for the platform

Several set-up configurations – one system

All the set-up configurations shown here are based on components from the Climbing system Xclimb 60. The various versions of the enclosure satisfy the differing requirements found on sites.

Protection screen Xclimb 60 with Framed enclosure Xbright

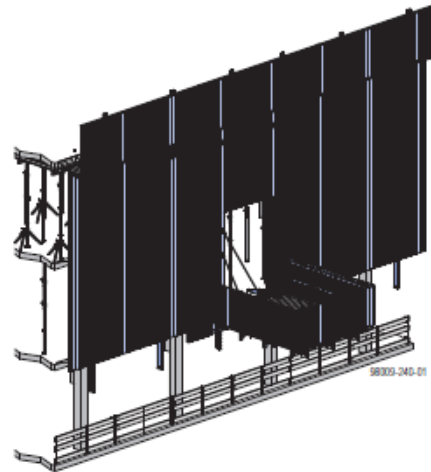
Gapless enclosure made of large-area frames, for safeguarding work on the floor-slab formwork. Loading platforms can be integrated in the protection screen, for inbound/outbound loading of equipment.



Protection screen Xclimb 60 with trapezoidal-sheet enclosure

Gapless enclosure made of trapezoidal metal sheet on a timber-beam grille, for safeguarding work on the floor-slab formwork.

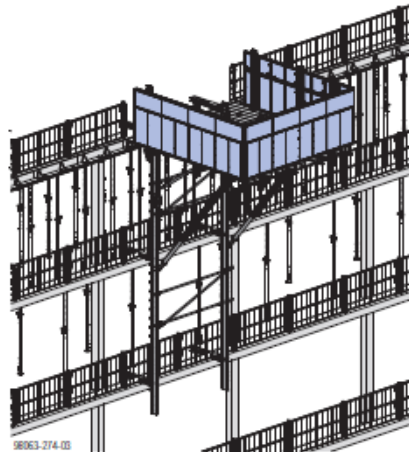
Loading platforms can be integrated in the protection screen, for inbound/outbound loading of equipment.



Follow the directions in the 'Protection screen Xclimb 60 with trapezoidal-sheet enclosure' User Information Booklet!

Loading platform Xclimb 60

An easy-to-reposition loading platform for constant or non-constant storey heights.



Hydraulic repositioning

Follow the instructions given under the heading "Repositioning" for safe resetting of the entire unit!



Important note:

No payload (service load) is allowed on the loading platform while it is being repositioned.



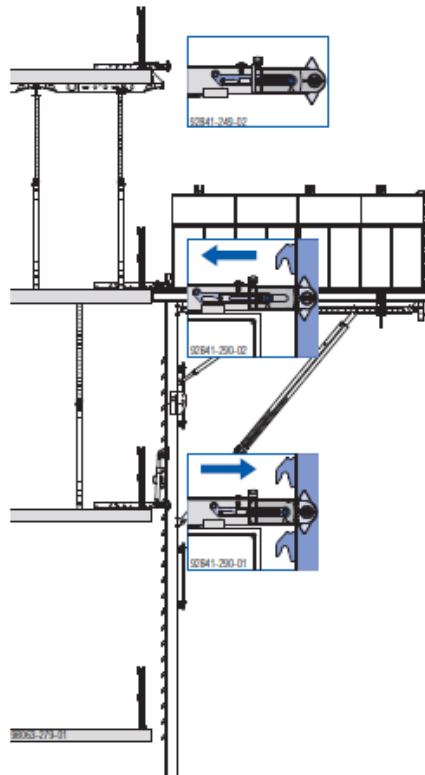
Follow the directions in the "Doka automatic climbing formwork Xclimb 60" Operating Instructions!

Repositioning operation

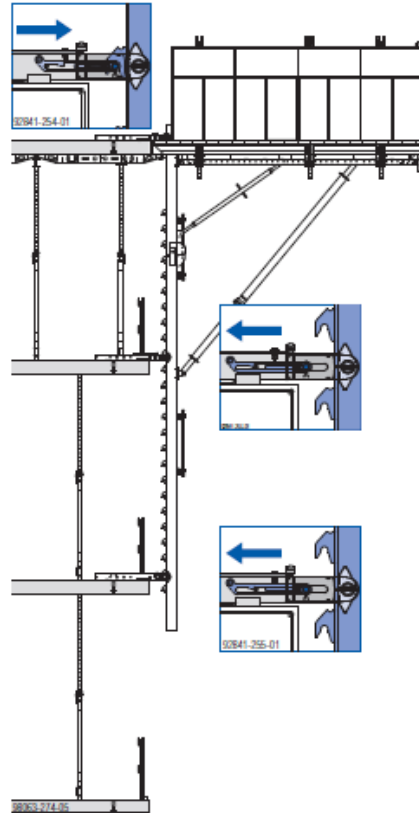
Lifting

See the section headed "Repositioning" for instructions on how to mount the hydraulic cylinders to the unit for repositioning.

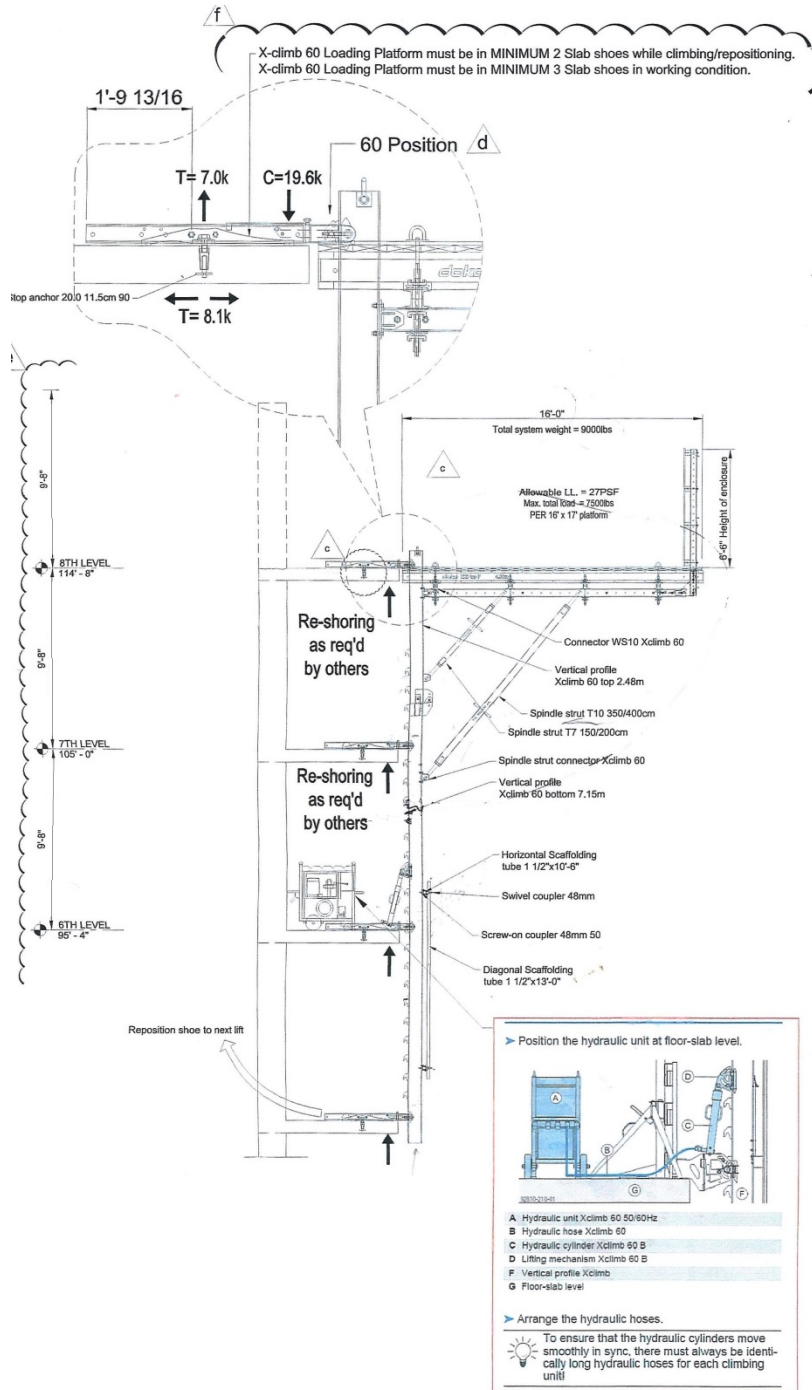
- Mount the 'Floor supports' (see the section headed 'Assembling and operating the Floor supports').
- Completely extend the hydraulic cylinders.
- Move the pressure bolts of the 'Floor supports' into position (see illustration).



- Continue raising the unit for repositioning, a step at a time, until the top climbing cam has risen max. 10 cm past the activated pressure bolt in the top "Guiding shoe".
- Lower the unit until the climbing cams are resting on the pressure bolts of the top 'Floor supports'.
- After the repositioning operation is complete, retract the cylinders, dismount them and transport them to the next unit for repositioning.



The hydraulic cylinders can be placed on the hydraulic unit ready for transport to the next location.



Section A-A

1/4" = 1'-0"



Section of the scaffold and hydraulic inut (from sheet 1530)

Investigation of the October 19, 2016, Collapse of Two Scaffold Platforms during Climbing in Miami, Florida

	<u>COMPONENT</u>	<u>WEIGHT (LB) BY LOCATION</u>		
		<u>WEST</u>	<u>SHARED</u>	<u>EAST</u>
<u>PLATFORM ELEVATION</u> <u>(SEE ABOVE)</u>	LARGE GANG BOX	1,067		
	LOOSE MATLS	132		
	WEST HR	81		
	TRANS TOOLBOX	217		
	TABLE 1 EFCO	918		
	TABLE 1 DOKA 400s	479		
	WEST PATCHES	31		
	MIDDLE HR		124	
	HOLE COVER		1,809	
	TABLE 1 ADDL EFCO		424	
	MIDDLE PATCH		14	
	COLUMN FORM			1,344
	EAST HR			110
	WATER BOX			406
	TABLE 2 EFCO			928
	TABLE 2 DOKA 400s			468
	TABLE 2 ADDL FMWK			976
	EAST PATCHES			35
<u>FORMWORK DECK</u> <u>(SEE NEXT PAGE)</u>	TABLE 1	1,601		
	TABLE 2			990
<u>TOP OF DECK</u> <u>(SEE NEXT PAGE)</u>	TABLE 1 HR	143		
	WEST EF	130		
	TABLE 2 HR			99
	DOOR BOs			265
	EAST EF			98
	TOTALS	4,799	2,371 (SPLIT)	5,719
		↓	↙ ↘	↓
		5,985		6,904

Materials on the platform (prepared by CECO)