



ARUP



A case study on maximizing the reuse of existing building and its foundations

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Introduction



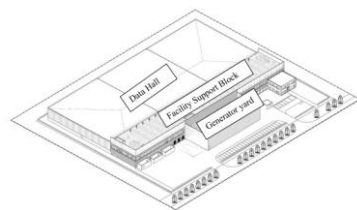
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- A Warehouse in the Netherlands
- Constructed and in use since 2000's
- Retrofit as a datacentre

Client requirements



- Global test fit to be accommodated in the plot
 - Template equipment locations
 - Loading requirements
- Design life 50 years

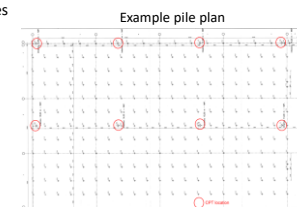


Area	Floor loading [kN/m ²]	Suspended loading [kN/m ²]
Data Halls	13	2.5
Mechanical corridor	11	4
External plant yard	25	N/A
Roof snow load	6	0.35
Loading Bay	25	0.5

Available information



- (Design) Drawings
 - Pile layout with dimensions, tip level and design forces
 - Ground floor slab reinforcement drawings
- Ground investigation data
 - CPTs
 - Geo-environmental boreholes
- No calculations or monitoring information



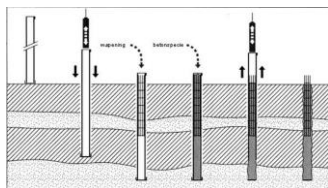


Existing foundation



- Four dimensions of Vibropile
- Designed as per NEN6743
- Pile tip levels varies between NAP -13.5 and -15.5m

Dimensions, Shaft/top	$F_{\text{permitted}}$	Nos. of piles
Ø273/330mm	680 kN	100
Ø324/390mm	910 kN	681
Ø355/430mm	1085 kN	29
Ø406/490mm	1375 kN	66

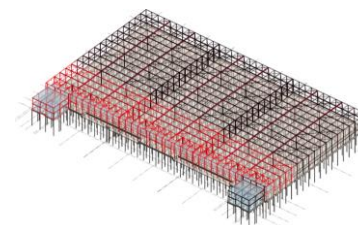


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Existing structure- reassessment



- Geotechnical- NEN 8707
 - Two pile dimensions analysed to confirm the allowed load in the pile plan.
- Structural- EN 1993
 - Floor slab loading low than the original design.
 - Roof cannot take any additional load.
 - FSB loads are very high that strengthening is required (red area in figure).



Adopted Design

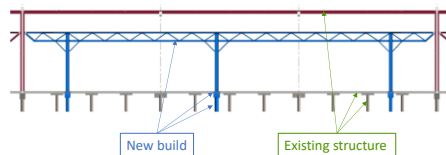


Considerations

- Minimise impact on existing piles.
- Construction strategy.

Data hall: Box-in-box

- Existing column, roof, floor, and piles fully reused
- New column, gantry and piles introduced for services

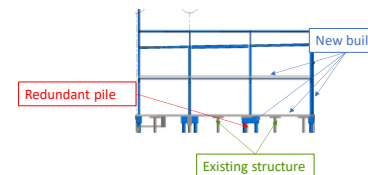


Adopted Design



FSB:

- Existing frames and slabs to be demolished
- New column, mezzanine, frame, and piles introduced.





Foundations



Design constraints

- DC Hall- Height and vibration restrictions.
- FSB- vibration restrictions.
- New piles to be positioned after consideration of its impact on existing piles.
- Temporary stability of the structure.

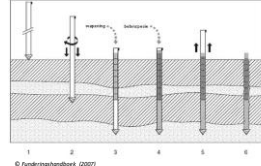
Utilisation of old pile	Old pile tip level = New pile tip level	New pile tip level > Old pile tip level
Yes	2D _o + 2D _n	3D _o + 3D _n
No	0.5D _o + 1D _n	

Foundations



New Piles

- Cast in-situ screwed displacement piles with permanent casing- DC Hall
- Cast in-situ screwed displacement piles with temporary casing- FSB



Capacity

- Existing piles as per NEN 8707 (old pile class factors)
- New piles as per NEN 9997-1

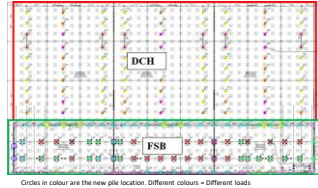
Building	Dimensions, Shaft/tip	R _{class}	Nos. of piles
DCH	ø457/560mm	725 kN	60
FSB	ø435/530mm	1235 kN	30
	ø470/560mm	1360 kN	283

Result



- Use of existing foundations at the original design capacity
- Maximum reuse of the existing pile foundations

Dimensions, Shaft/tip	F _{limit}	Nos. of piles	Reused nos. of piles (approx)
ø273/330mm	680 kN	100	62
ø324/390mm	910 kN	681	647
ø355/430mm	1085 kN	29	16
ø406/490mm	1375 kN	66	62



Risks and mitigation (future) measures



Risks	Mitigation (future) steps
As-built piles not in line with the design drawings	Allow additional tolerances in the design for the pile positioning
Heave from installation of new piles	Impact of the heave to be considered on the slabs and critical piles
Integrity of the existing building	New investigation to be performed on the existing structure
Impact of new piles on existing piles	<ul style="list-style-type: none"> • New ground investigations to be performed and to be considered in the design • Estimate stiffness for the existing pile, and consider interaction between existing and new pile in the design



Recommendations



- **Proper documentations- Both design and as-built**
 - New piles could be efficiently designed (positioning)
 - Reliability on the old piles behaviour
- **Consider monitoring or allowing access for testing**
 - Could have helped in interaction between existing and new piles