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Scour Behaviour of Bucket Foundations

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Abstract

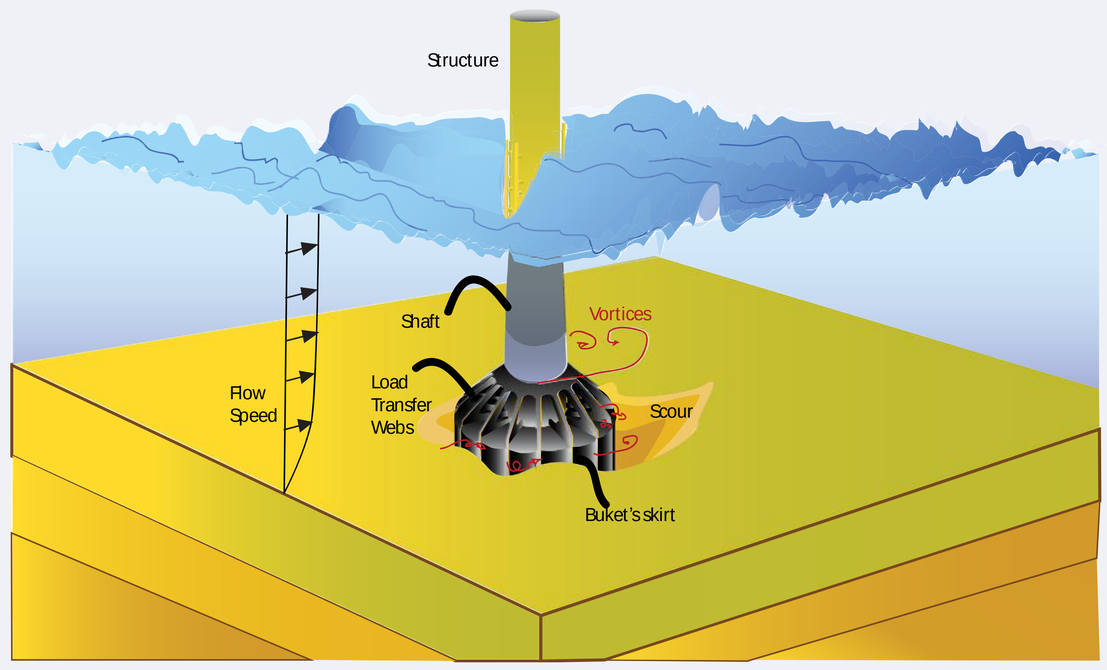
Bucket Foundation and Scour

1. Bucket Foundation

Innovative caisson foundation (mono-pad or multi-pad) that uses differential pressure to penetrate into the soil

2. Scour

Soil erosion around a foundation in offshore conditions caused by currents and waves



Importance of No Scour Protection

1. Low Costs

No costs compared to 0.15 mil € for protection of a standard wind turbine monopile foundation

Ref. 1

2. High Safety

Unprotected monopile may loose stability or collapse in most attractive wind farm sites due to scour conditions

3. No Environment Impact

No disturbance of neither inland nor sea environments by removing onshore rocks to dump on seabed

Objectives

Experience from real Projects

Present the bathymetry results from latest scour surveys around the bucket foundations installed in the North Sea.

Methods

Horns Rev II

1. Design Conditions

H_{max} = 15 m | $U_{current}$ = 1.5 m/s

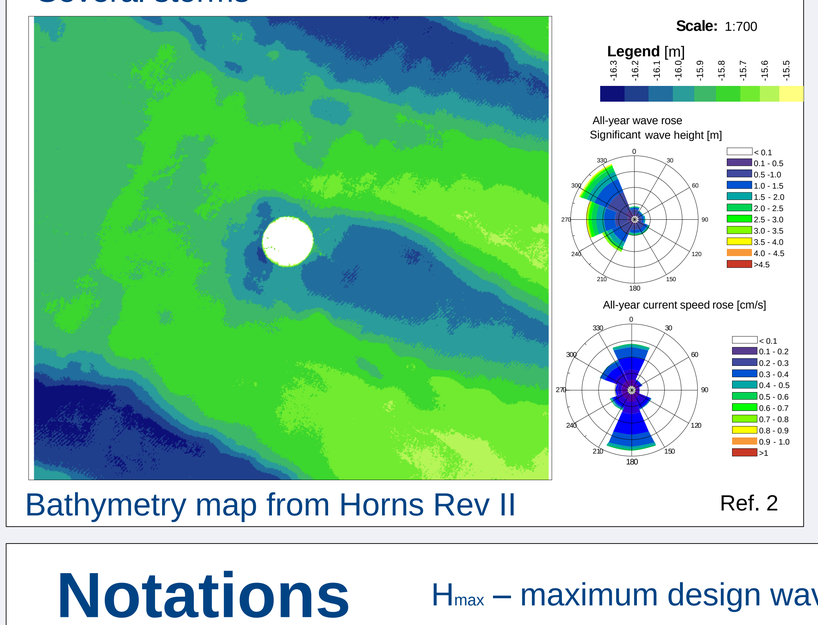
D_{bucket} = 12 m | D_{shaft} = 4.5 m | ratio 2.7

2. Survey Results after 4.5 years

Scour = 0.6

3. Experienced Sever Storms

Several storms



Bathymetry map from Horns Rev II

Ref. 2

Dogger Bank E.

1. Design Conditions

H_{max} = 19 m | $U_{current}$ = 1.1 m/s

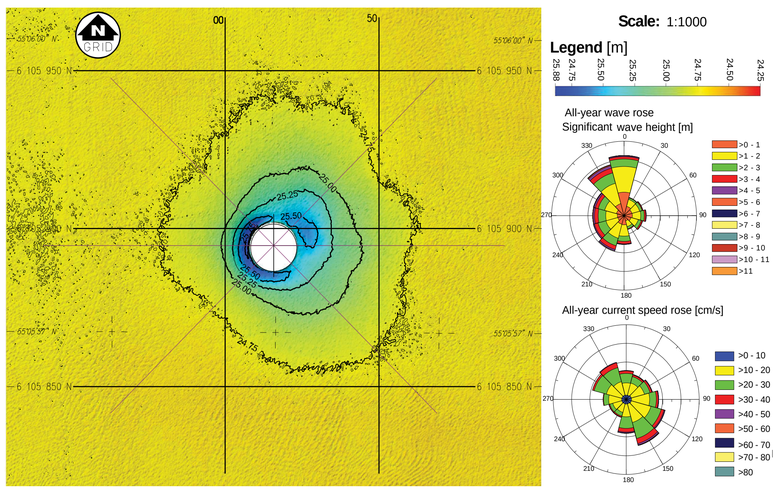
D_{bucket} = 15 m | D_{shaft} = 4.0 m | ratio 3.8

2. Survey Results after 1.6 years

Scour = 1.0 m

3. Experienced Sever Storms

Two storms



Bathymetry map from Dogger Bank location East

Ref. 3

Dogger Bank W.

1. Design Conditions

H_{max} = 19 m | $U_{current}$ = 1.0 m/s

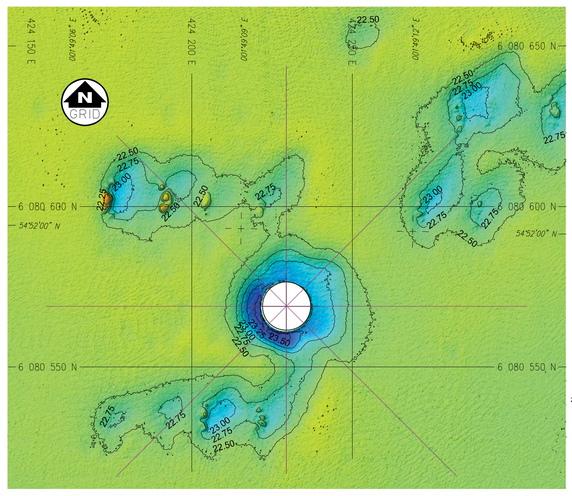
D_{bucket} = 15 m | D_{shaft} = 4.0 m | ratio 3.8

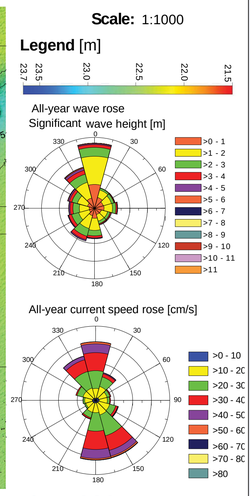
2. Survey Results after 1.1 years

Scour = 0.8m

3. Experienced Sever Storms

Two storms





Bathymetry map from Dogger Bank location West

Ref. 3

Notations

H_{max} – maximum design wave height; $D_{bucket/Dshaft}$ – diameters of the Bucket Foundation; $U_{current}$ – maximum design current speeds;

Conclusions

Findings

1. The caisson acts as a scour protection in the vicinity of the shaft/legs
2. The scour development around bucket foundations is insignificant in flow speeds less than 1 [m/s]
3. The predominate current flow will scour sediments around the bucket; while, predominate waves flow will backfill the hole

Guidelines

1. Diameter of caisson to shaft/legs diameter ratio larger than 2.7 will increase the protection against scour and will generate backfill
2. With caisson's lid as close to seabed when completed installation limited the scour from the exposed skirt
3. The installation time must be decayed with respect to the tide maximum intensity to limit the time of exposed skirt which generates scour during installation

References

1. Prediction scour in offshore wind turbines - now a breeze, DHI Water and Environment
2. Bathymetry Survey, DONG Energy A/S
3. Bathymetry Survey, Universal Foundation A/S