# Experimental data of deposition patterns around buildings at the beach: the effect of building spacing and orientation

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This repository contains the data of scale experiments performed at the beach to determine the effect of building configuration on the deposition patterns around buildings. Experiments were performed with scale models of 0.5x1x0.5m (WxLxH), placed at the beach for approximately 1 day. Aspects examined are:

- Building orientation to the wind (experiment A, F)
- Building spacing (experiment B, C, G)
- Combinations of building orientation and spacing (experimetn D, E)
- Effect of pile height for buildings on piling (experiment H-1)
- Effect of building group size (experiment H-2)

Experiment A-E are used in the paper "Deposition patterns around buildings at the beach: the effect of building spacing and orientation" by Daan W. Poppema, Kathelijne M. Wijnberg, Jan P.M. Mulder and Suzanne J.M.H. Hulscher (submitted).

This series of experiments examines the effect of building configuration. For a previous series, on the effect of building size and shape, see doi.org/10.1016/j.coastaleng.2021.103866

## Configuration of experiments

The set-up of the experiments is described in table 1 and table 2 and sketched in figure 1. At the end of the ReadMe, some photos follow to illustrate the experimental configurations and results.

*Table 1: Set-up of the experiments with individual scale models*

| Experiment | Date (in 2019) | | Variables tested | Number of set-ups | Orientation baseline to wind [°] | Orientation object to baseline [°] | Piling height [cm] |
|---|---|---|---|---|---|---|---|
| | built | surveyed | | | | | |
| A | 12-04 | 15-04 | Object orientation | 9 | 21; 32; 35; 51; 70; 81; 93; 112; 173 | 90 | - |
| F | 26-04 | 27-04 | Object orientation | 9 | 90 | 90 | - |
| H-1 | 10-05 | 12-05 | Pile height | 6 | 90 | 90 | 0; 10; 20; 30; 40; 50 |

*Table 2: Set-up of the experiments of with groups of adjacent, parallel scale models*

| Experiment | Date (in 2019) | | Variables tested | Number of set-ups | Gap width [cm] | Gap ratio g* [-] | Group size | Remark orientation |
|---|---|---|---|---|---|---|---|---|
| | built | surveyed | | | | | | |
| B | 11-04 | 12-04 | Gap width | 6 | 0; 25; 50; 100; 150; 200 | 0; 0.33; 0.5; 0.67; 0.75; 0.8 | 3 | |
| C | 24-04 | 25-04 | Gap width | 7 | 0; 25; 50; 100; 150; 200; 300 | 0; 0.33; 0.5; 0.67; 0.75; 0.8; 0.86 | 3 | |
| D | 13-05 | 14-05 | Gap width, with oblique group orientation | 6 | 0; 25; 50; 100; 150; 200 | 0; 0.33; 0.5; 0.67; 0.75; 0.8 | 3 | Baseline 60° to wind |
| E | 14-05 | 15-05 | Gap width, with oblique object orientation | 6 | 0; 3; 21; 56; 91; 127 | 0; 0.06; 0.29; 0.53; 0.65; 0.72 | 3 | Object 45° to baseline |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| G | 27-04 | 28-04 | Gap width | 4 | 0; 25; 50; 100 | 0; 0.33; 0.5; 0.67 | 3 | Some models rotated by wind |
| H-2 | 10-05 | 12-05 | Group size | 4 | 50; 100; 50; 100 | 0.5; 0.67; 0.5; 0.67 | 3; 3; 6; 6 | |

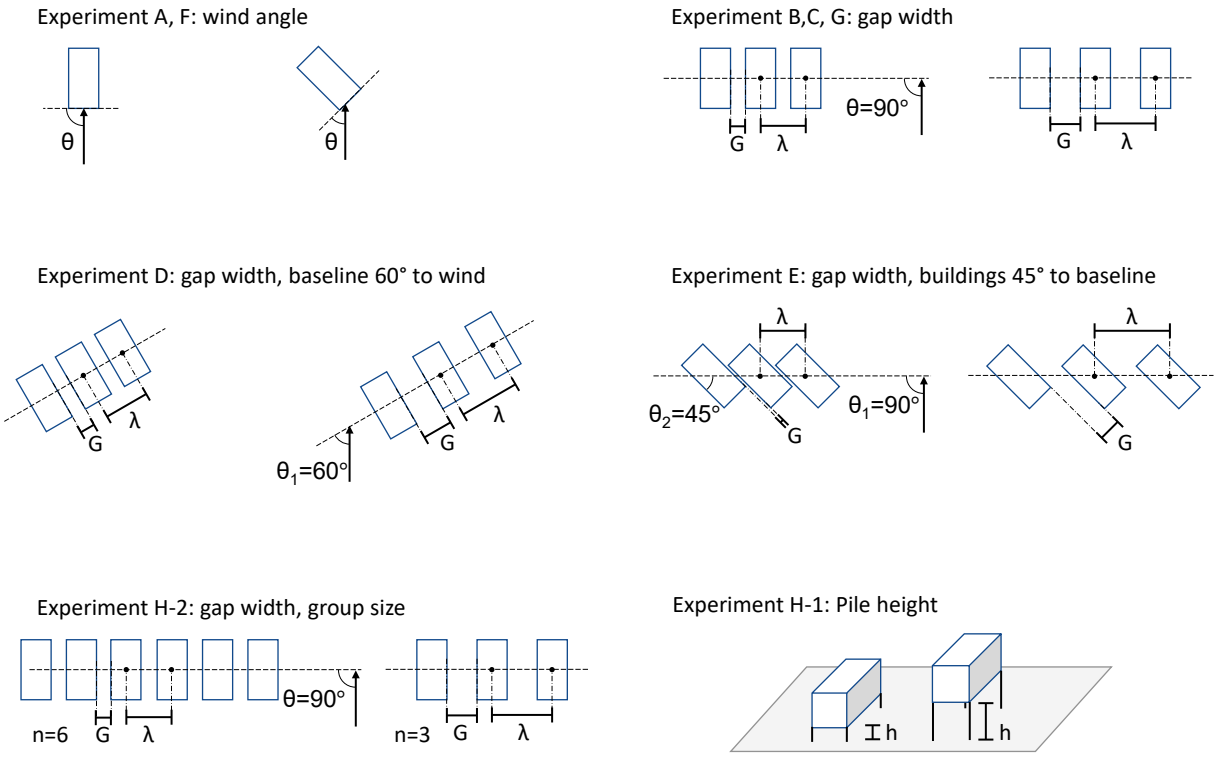


*Figure 1: Overview of the variables tested in the experiment. In experiment Arrows indicate wind direction, dashed lines indicate the baseline, $\vartheta_1$ (Experiment D, E) indicates the angle of the base line to the wind, $\vartheta_2$ (Experiment E) the angle of the building to the base line. Note that the centre-to-centre distance λ was the same for experiment E and experiments B-D, but that the resulting gap width differed between experiments due to staggered positioning of the buildings.*

Additional notes on the experiments:

- In experiment F the deposition tails behind scale models were so long that they mixed.
- In experiment G some scale models were inadvertently rotated or moved by the wind.
- Experiment H-1 and H-2 were placed at the beach at the same time, and surveyed simultaneously.

The bed around buildings is measured using structure-from motion (SfM) photogrammetry to determine deposition and erosion. In addition wind speed and direction are measured using a wind station, the occurrence of sediment transport at various elevations above the bed is measured using Wenglor laser particle counters and timelapses of the experiments are recorded.

## Data in repository

The following data is available in the data repository

- Raw data: Agisoft Metashape photogrammetry files + photos used for photogrammetry
- Raw data: wind speed, wind direction, sand transport data
- Timelapse, drone overview photos and detail photos of experiments
- Processed data: digital elevation models, orthophotos of set-ups
- Processed data: length of deposition tails

Table 3 describes which data is available per experiment:

*Table 3: Data availability per experiment*

| Experiment | Raw data: photos, photo-grammetry files | Processed data: DEM, orthophoto | Wind data | Transport data (Wenglors) | Timelapse | Drone photos (overview/ topview) | Detail photos |
|---|---|---|---|---|---|---|---|
| A | Yes | Yes, plus deposition tail length[1] | Windsonic. Last part: KNMI | Yes. Last part misses | No | No | Yes |
| B | Yes | Yes | WindSonic | Yes | Yes | Yes | Yes |
| C | Yes | Yes | KNMI | No | Yes | Yes | no |
| D | Yes | Yes | WindSonic | Yes | No | Yes | Yes |
| E | Yes | Yes | WindSonic | Yes | No | Yes | Yes |
| F | Yes | Yes | WindSonic | Yes | No | No | Yes |
| G | Yes | Yes | KNMI | No | Yes | Yes | Yes |
| H | Yes | Yes | WindSonic | Yes | No | 2 days later | Yes |

[1] In addition to the normal orthophoto and DEM, experiment A has extra data on the length of the downwind deposition tails. This includes the measured length of the deposition tails and the binarized orthophotos that were part of the process of measuring these deposition lengths.

The data and the methods used to obtain the data are further described below. The methods used in the experiment are further described in Poppema et al (submitted).

**Raw data: photos, photogrammetry files**

The photos of the experiments were taken from a height of 5m, using a Phantom 4 Pro drone and an Olympus E-PL7 camera on a telescopic stick. Photos are taken approximately 1 day after placing the scale models on the beach (see also table 1). Drone photos are of a 20 megapixel resolution, taken in jpeg with a fixed 8.8mm lens (74° horizontal angle of view). Photos taken with the Olympus camera are of 16 megapixel resolution, taken in raw with a 20 mm lens (47° horizontal angle of view). The typical pixel footprint size was approximately 1 mm for individual photos.

The structure-from-motion (SfM) photogrammetry is performed with Agisoft Metascan, version 1.5.3 to 1.6. Photogrammetry project files contain Tie points, dense clouds, digital elevation models (DEMs) and orthophotos.

The photogrammetry files are georeferenced using ground control points (individual points with a known location) and scale bars (sets of points with a known distance between them). Ground control points were measured using an RTK GPS, with an accuracy of approximately 2cm. The location of these markers is uploaded per experiment in 2 files. The second file contains the same data, but has the formatting adapted and column headers removed so that it can be directly imported into Agisoft Metashape.

**Processed data: DEM, orthophoto**

The DEMs and orthophotos are available separately, as georeferenced tiff files. Orthophotos are additionally available as down-sampled jpg files. To more easily distinguish deposition and erosion, DEMs are filtered. The original DEMs contain the elevation relative to NAP (Amsterdam ordinance datum). The filtered DEM contain the elevation relative to a fitted surface, to remove general trends of the sloping beach and focus on local deviations from this trend, i.e. deposition, erosion and natural bedforms. This fitted surface is a linear surface ($z=a+bx+cy$) for DEMs with 'linearly filtered' in the name. The surface is quadratic ($z=a+bx+fy+dx^2+ey^2+fxy$) for DEMs with with 'quadratically filtered' in the name.

**Wind, Wenglor data**

The wind speed and direction were measured using a 2D Windsonic ultrasonic anemometer, at 1.8 m height and using a sampling frequency of 0.2 to 0.6 Hz. The height of the saltation layer was measured by a vertical array of 10 Wenglor laser particle counters. The Wenglors were positioned between 5 and 100 cm above the bed. By comparing the observed particle flux at different elevations above the bed, the height of the saltation layer can be determined, and compared to the scale model height (0.5m).

On the last day of experiment A, when sand transport had already stopped, WindSonic and Wenglors stopped recording due to an empty battery. For experiment C, no WindSonic and Wenglors were employed because of the thunderstorm. For experiment G, no Windsonic and fewer Wenglors were employed. In all three cases, wind data was retrieved from a public KNMI weather station at Hoek van Holland (http://projects.knmi.nl/klimatologie/uurgegevens/), at 9 km distance and an 1-hour interval. This station measured the hourly averaged windspeed and direction at 15m above the ground. Windspeed measurements were converted to a height of 1.8 m, as measured by the WindSonic anemometer in the other experiments, using a constant difference of 2m/s, based on a comparison of WindSonic and KNMI measurements for the other experiments.

In experiment A, the WindSonic was likely not properly aligned to the north, given that the direction of sand ripples in areas without scale models was consistent with a wind direction from a somewhat more northerly direction than derived from the Windsonic data. The average direction of the deposition tails downwind of the scale models was also in line with this more northerly wind direction, which deviated by 12° from the Sonic-derived wind direction. Uploaded Windsonic data contains the original, uncorrected wind direction measurements.

In the experiment, the WindSonic and the top five Wenglors (40, 50, 60, 80, 100 cm above the bed) were connected to the same datalogger. The lowest five Wenglors (3, 8, 13, 20, 30 cm above the bed) were connected to a second datalogger. For the uploaded files, observations are split in three separate files: the wind data; the lowest wenglors; and the highest wenglors. Wind direction measurements are in degrees, measured clockwise from the north (i.e. 0° means wind coming from the north, 90° from the east). Wenglor counts indicate the number of grains that are counted.

**Timelapses**

Timelapse photos are taken with a SJCAM SJ7Star action camera, from a height of approximately 5m and with a 10-second sampling interval. Photos are edited to increase contrast and then combined into a timelapse movie. This timelapse movie is uploaded.

**Drone photos; detail photos**

To illustrate the set-up and results of the experiments, several photos are available. Depending on the experiment, there are an overview photos of the entire experiment (taken by drone), top view photos per scale model/scale model group (taken by drone) and photos with details of the experiment (handheld photos).

## Impression of the experiments

On the next pages follow some photos and elevation maps for an impression of the experiments.

**Experiment A: Building orientation to wind**

*Figure 2: Orthophoto (left) and photo (right) of experiment A*

**Experiment B: building spacing**

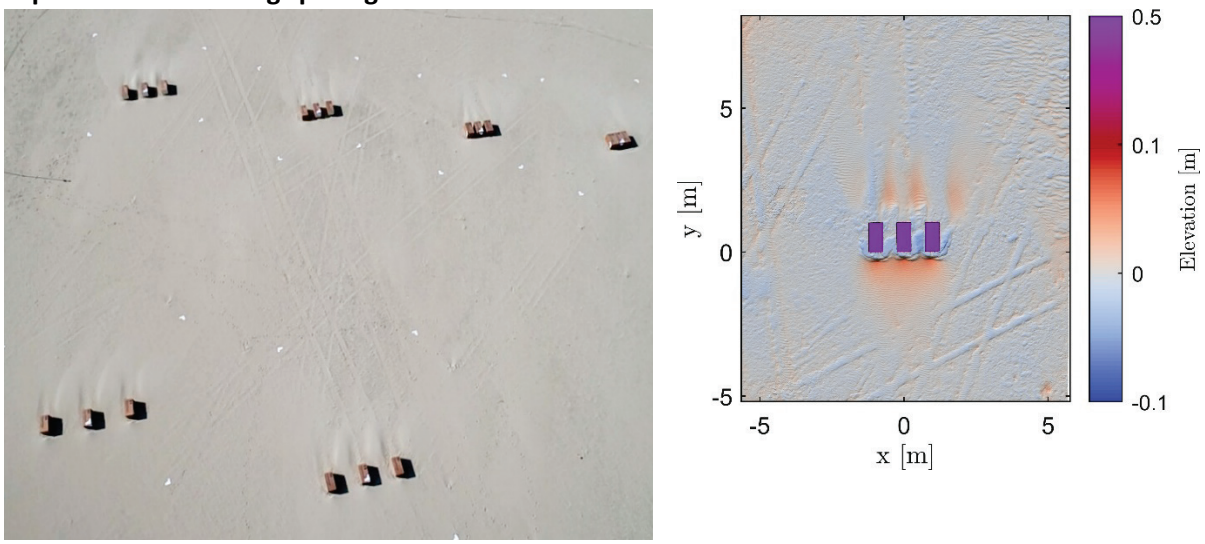


*Figure 3: Photo (left) and detail of digital elevation model (right) of experiment B*

**Experiment C: building spacing**

*Figure 4: Photo experiment C*

**Experiment D: Building spacing with oblique group orientation**

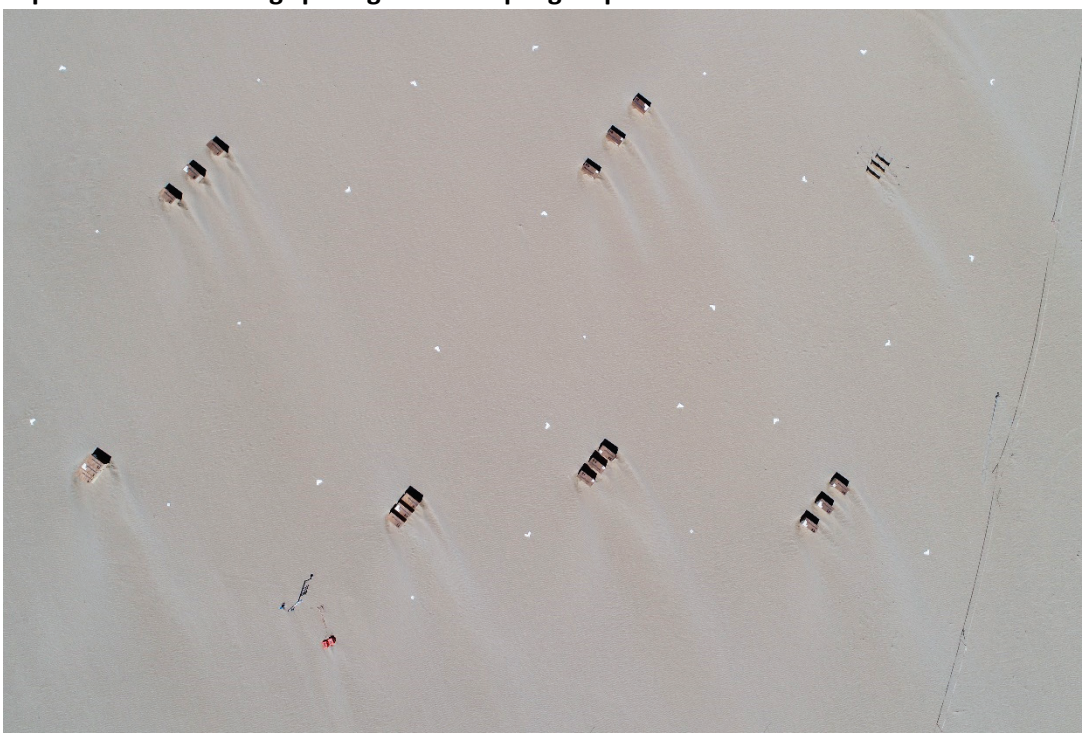

*Figure 5: Photo experiment D*

**Experiment E: Building spacing with oblique building orientation**

*Figure 6: Photo of experiment E*

**Experiment F: Building orientation to wind**

*Figure 7: Photo of three of the scale models of experiment F, with the timelapse camera, WindSonic wind sensor and Wenglor particle counters in the background.*

**Experiment G: building spacing**

*Figure 8: Photo of experiment G. The two set-ups on the right each have a scale model that is rotated by the wind.*

**Experiment H: group size, pole height**

*Figure 9:Photo of experiment H, with the scale models with varying pole height on the left, and two of the set-ups with varying group size in the background on the right.*