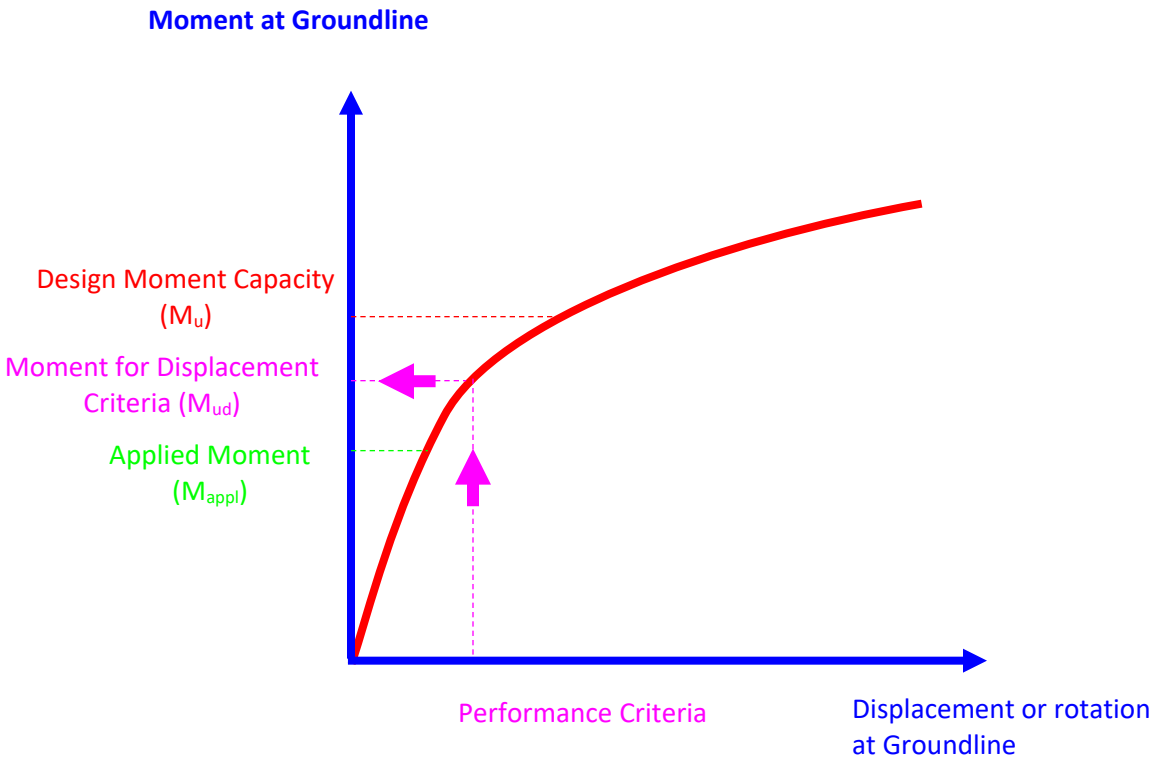
Improving methodology to select Controlling Load Case and increasing transparency.

The methodology to select the controlling load case in MFAD now considers performance criteria. (see Figure 1 below); and MFAD's geotechnical report shows the summary results from all load cases so that users can independently verify the controlling case that FAD is selecting.



Controlling load Case in FAD: Load Case with the largest Load Ratio

$$Load\ Ratio = \frac{M_{appl}}{M_u}$$

Improvement. Adding performance criteria as:

$$Load\ Ratio = \frac{M_{appl}}{M_{ud}}$$

Figure 1. Including performance criteria in the controlling load case selection process in MFAD.

Summary of Capacity Verification for all load cases.

Load Case No.	Load Case Name	Shear Design Capacity / Applied Shear Load	Moment Design Capacity / Applied Moment Load
1	DL+0.75L+0.45W+H	12.1 / 15.0 = 0.80	66.0 / 82.0 = 0.80
2	DL+0.6W+H	11.0 / 10.5 = 1.05	72.2 / 69.0 = 1.05

Summary of Performance Verification for all load cases at Groundline.

Load Case No.	Load Case Name	Total Displacement Criteria/ Total Displacement	Total Rotation Criteria/ Total Rotation	Nonrecoverable Displacement Criteria/ Nonrecoverable Displacement	Nonrecoverable Rotation Criteria/ Nonrecoverable Rotation
1	DL+0.75L+0.45W+H	0.5 / 1.6 = 0.31	0.3 / 1.3 = 0.19	0.3 / 0.5 = 0.58	0.2 / 0.5 = 0.33
2	DL+0.6W+H	0.5 / 1.0 = 0.51	0.3 / 0.8 = 0.31	0.3 / 0.2 = 1.22	0.2 / 0.2 = 0.65

Figure 2. New tables have been added to the report to show summary results for all load cases.

Appendix. Detailed description of the modification.

Three modifications are made:

- Use the applied moment and the moment capacity at the same location, that is, at the groundline. FAD 5.2.2 and older versions calculate the load ratio by using the applied moment at top of the shaft and the moment capacity at the groundline. This is typically acceptable for the analysis of monopoles foundations where the eccentricity of the applied load is more than 10 ft. But cases such as the one in Figure 3 below, could result in the incorrect controlling load case selection.
- Introduce the influence of the displacement criteria or performance criteria to the controlling load case selection as shown in Figure 1. The idea is to use an equivalent Moment capacity (e.g. M_{ud} in Figure 1).
- Add Tables showing the summary results for all load cases (see Figure 2).

Values in Figures 2 and 3 can be replicated with the following input file https://www.fadtools.com/FAD_Input_Files/ControllingLoadCaseExample.zip . This input file (#.fadt) is for FAD 5.2.2. If the file is open with FAD 5.2.3, the database will be updated automatically after creating a copy of the FAD 5.2.2 compatible version. Results “Before Modification” in Figure 3 can be obtained using FAD 5.2.2 and its compatible input file, while “After Modification” results in Figures 2 and 3 can be replicated with FAD 5.2.3 and its compatible input file.

Before Modification

DESIGN RESULTS

Diameter of Drilled Shaft: [ft]	2
Stick up above Ground Level: [ft]	4
Depth of Embedment: [ft]	8
Total Foundation Length: [ft]	12
Controlling Applied Load Case Name:	DL+0.6W+H

Capacity Verification

Loading Mode	Applied Load at Top of Shaft	Applied Load at Groundline	Nominal Capacity at Groundline	Design Capacity at Groundline*	Design Capacity / Applied Load at Groundline
Shear Load [kips]	10.50	10.50	17.43	10.98	1.05
Moment [kip-ft]	27.00	69.00	114.56	72.17	1.05

Design Capacity is based on a Strength Factor of 0.63

Performance Verification

	Criteria at Groundline	Actual at Groundline	Actual at Top of Shaft
Total Displacement [in]	0.50	0.98	1.67
Total Rotation [deg.]	0.25	0.81	0.81
Nonrecoverable Displacement [in]	0.30	0.25	0.44
Nonrecoverable Rotation [deg.]	0.15	0.23	0.23

After Modification

DESIGN RESULTS

Diameter of Drilled Shaft: [ft]	2
Stick up above Ground Level: [ft]	4
Depth of Embedment: [ft]	8
Total Foundation Length: [ft]	12
Controlling Applied Load Case Name:	DL+0.75L+0.45W+H

Capacity Verification

Loading Mode	Applied Load at Top of Shaft	Applied Load at Groundline	Nominal Capacity at Groundline	Design Capacity at Groundline*	Design Capacity / Applied Load at Groundline
Shear Load [kips]	15.00	15.00	19.16	12.07	0.80
Moment [kip-ft]	22.00	82.00	104.75	65.99	0.80

Design Capacity is based on a Strength Factor of 0.63

Performance Verification

	Criteria at Groundline	Actual at Groundline	Actual at Top of Shaft
Total Displacement [in]	0.50	1.61	2.73
Total Rotation [deg.]	0.25	1.32	1.32
Nonrecoverable Displacement [in]	0.30	0.52	0.91
Nonrecoverable Rotation [deg.]	0.15	0.46	0.46

Figure 3. Example case with different results before/after modification.