CITY OF CHICAGO

DEPARTMENT OF BUILDINGS

CODE MEMORANDUM

To: Plan Examiners/Reviewers

From: Judith Frydland
Commissioner

Date: July 21, 2016

Re: Earth Retention Systems

Effective July 21, 2016, any necessary Earth Retention System (ERS) approvals must be included in the structural review scope (including also the deep foundation projects).

The ERS submittal to the Office of Underground Coordination (OUC) in the Chicago Department of Transportation (CDOT) and the development of public way damage control program (as required) will remain under the scope of the geotechnical review. Other than the above change, the responsibilities and duties of the structural and the geotechnical reviews will remain the same and the geotechnical reviews and the related OUC submittals will remain in-house at DOB.

For references and convenience, attached please find submittal requirements that were previously used for ERS. Please refer any questions Avikam Hameiri at Avikam.Hameiri@cityofchicago.org.

SEE ITEMS 2→6 FOR ERS

CITY OF CHICAGO Submittal Requirements for Review of Earth Retention Systems and Other Calculations

Required	Submitted	Number	Category	Description
☐	☐	1.	Common Items for Foundations	The Following items are to be included with all calculations submittals, regardless of the structural type. All foundation drawings must be sealed and signed by an Illinois registered Structural Engineer. Foundation calculations must be sealed and signed by an Illinois registered Civil Engineer.
☐	☐	1.1	Common Items for Foundations	Boring logs and associated field/lab test data.
☐	☐	1.2	Common Items for Foundations	A Geotechnical Report for the project.
☐	☐	1.3	Common Items for Foundations	List all design assumptions used in the calculations, as they are introduced in sequence of computations.
☐	☐	1.4	Common Items for Foundations	Provide copies of relevant pages of references used in the calculations, including all graphs, charts, or tables used in the analysis or design.
☐	☐	1.5	Common Items for Foundations	All submittals must begin with a sketch and/or listing of soil layering, soil parameters, and design water level assumed in the calculations. Specific borings which were used in establishing the design conditions should be identified by boring numbers as given on the logs.
☐	☐	1.7	Common Items for Foundations	Calculations should show cross-sections giving design elevations for:
☐	☐	1.7.1	Common Items for Foundations	Top and bottom of the foundation.
☐	☐	1.7.2	Common Items for Foundations	Foundation dimensions.
☐	☐	1.7.3	Common Items for Foundations	Existing surrounding ground.
☐	☐	1.7.4	Common	Bottom of the excavation.

			Items for Foundations	
☐	☐	1.7.5	Common Items for Foundations	Existing adjacent foundations within the zone of influence.
☐	☐	1.7.6	Common Items for Foundations	Cut slopes and set-backs.
☐	☐	1.7.7	Common Items for Foundations	Water elevation.
☐	☐	1.8	Common Items for Foundations	All formulas must be listed as they are being used in the various parts of the calculations. Formulas should include standard symbols and each symbol used should be explained.
☐	☐	1.9	Common Items for Foundations	Include all calculation steps that are a normal part of an actual hand solution, whether or not a computer-assisted analysis/design was used. Do not submit re-copied computer output as hand calculations.
☐	☐	1.10	Common Items for Foundations	Construction surcharge should be matched to the actual conditions planned by the constructors. However, in no case, should traffic surcharge be less than a 240 psf uniformly distributed vertical load.
☐	☐	1.11	Common Items for Foundations	Foundation drawings must include plan views and cross-sections that are consistent with the final design options, eliminating alternatives. Sufficient cross-sections must be provided to show top of grade, cutback slopes, adjacent buildings, sidewalks, alleys, and roadways, as well as utilities with the zone of influence (within 2.5 times the excavation depth from grade).
☐	☐	1.12	Common Items for Foundations	A Groundwater Control Plan and dewatering calculations prepared by an Illinois registered PE must be submitted for review in all cases where well/wellpoints and/or dewatering are necessary to maintain a dry, stable excavation.
☐	☐	1.13	Common Items for Foundations	Building Code number should be included when applicable.
☐	☐	2.	Common Items for ERS	The Following items are to be included with all earth retention system (ERS) submittals, regardless of the structural type. All ERS drawings and calculations must be sealed and signed by an Illinois registered Structural Engineer.
☐	☐	2.1	Common Items for ERS	Boring logs and associated field/lab test data.

☐	☐	2.2	Common Items for ERS	A Geotechnical Report for the project.
☐	☐	2.3	Common Items for ERS	List all design assumptions used in the calculations, as they are introduced in sequence of computations.
☐	☐	2.4	Common Items for ERS	Provide copies of relevant pages of references used in the calculations, including all graphs, charts, or tables used in the analysis or design.
☐	☐	2.5	Common Items for ERS	Provide copies of catalogue cuts and tables of material properties used in the structural calculations.
☐	☐	2.6	Common Items for ERS	All submittals must begin with a sketch and/or listing of soil layering, soil parameters, and design water level assumed in the calculations. Specific borings which were used in establishing the design conditions should be identified by boring numbers as given on the logs.
☐	☐	2.7	Common Items for ERS	Calculations should show cross-sections giving design elevations for: i. Top and toe of the foundation. ii. Foundation dimensions. iii. Existing surrounding ground. iv. Bottom of the excavation. v. Existing adjacent foundations within the zone of influence. vi. Cut slopes and set-backs. vii. Water elevation.
☐	☐	2.8	Common Items for ERS	All formulas must be listed as they are being used in the various parts of the calculations.
☐	☐	2.9	Common Items for ERS	Include all calculation steps that are a normal part of an actual hand solution, whether or not a computer-assisted analysis/design was used. Do not submit re-copied computer output as hand calculations.
☐	☐	2.10	Common Items for ERS	Construction surcharge should be matched to the actual conditions planned by the constructors. However, in no case, should traffic surcharge be less than a 240 psf uniformly distributed vertical load.
☐	☐	2.11	Common Items for ERS	ERS drawings must include plan views and cross-sections that are consistent with the final design options, eliminating alternatives. Sufficient cross-sections must be provided to show top of grade, cutback slopes, adjacent buildings, sidewalks, alleys, and roadways, as well as utilities with the zone of influence (within 2.5

				times the excavation depth from grade).
☐	☐	2.12	Common Items for ERS	A Groundwater Control Plan and dewatering calculations prepared by an Illinois registered PE must be submitted for review in all cases where well/wellpoints and/or dewatering are necessary to maintain a dry, stable excavation.
☐	☐	2.13	Common Items for ERS	ERS drawings must include a step-wise installation and dismantling procedure.
☐	☐	3.	Earth Retention System (ERS) Items – General	The ERS submitted must include calculations for the design of all vertical wall components and for all bracing components. For example, depending on the system selected, this may include design for: • Sheet piles, soldier piles and lagging, secant piles, slurry walls, etc. • Walers, struts, rakers, kicker blocks, anchors, and temporary earth berms. • Supports for crossing utilities that are not relocated. • Use of proprietary systems, such as trench boxes or slide rail shoring, require that a structural engineer licensed in the state of Illinois confirm that the systems components are satisfactory for site-specific conditions. Manufacturers or suppliers cut sheets must be submitted, listing serial numbers of frames or boxes proposed for use on the project. Such cut sheets must clearly state the maximum loading and depths for which the system has been designed. These cut sheets must be stamped by the structural engineer (licensed in Illinois) who is approving the use of such system.
☐	☐	4.	Items Specific to Cantilever Wall Analysis/ Design	In addition to the items listed under Part I and II above, the following must be included as part of the submission.
☐	☐	4.1	Items Specific to Cantilever Wall Analysis/	Provide a step-wise calculation of lateral pressure distribution. Calculate pressures at every change of state of the problem, e.g. top and bottom of each layer, stratum boundaries excavation depth, brace or anchor level, adjacent foundation load as it varies with depth.

			Design	
☐	☐	4.2	Items Specific to Cantilever Wall Analysis/ Design	Plot separate active and passive lateral pressures diagram (not net) to reasonable size for illustration. Split diagram into sensible triangular and rectangular units; identify units by letter or number for use in moment equations. Account for all components of load: soil, water, and surcharge.
☐	☐	4.3	Items Specific to Cantilever Wall Analysis/ Design	In cases where a theoretical negative or small positive active earth pressures are predicted through clay strata, a minimum active earth pressure of 0.25 γz should be substituted, where γz is the total overburden pressure at depth z.
☐	☐	4.4	Items Specific to Cantilever Wall Analysis/ Design	Provide moment calculations based on above pressure diagram, solving for wall embedment depth required for rotational equilibrium (SF=1.0) about the toe. Show intermediate steps, reducing moment expression to its final form for solution. Find zero shear, maximum moment to size sheeting.
☐	☐	4.5	Items Specific to Cantilever Wall Analysis/ Design	Provide additional embedment length to establish safety factor or margin of safety vs. rotational failure about the toe. Any of the generally recognized methods of determining design embedment depth may be used. However, a minimum safety factor of 1.5 vs. ultimate passive resistance is required in all cases.
☐	☐	4.6	Items Specific to Cantilever Wall Analysis/ Design	Provide analysis of structural wall deflection and also ground deformation required to mobilize passive resistance. The support assumption for structural deflection should be consistent with figure 6.1 of the U.S. Army Corps of Engineers EM 1110-2-2504 "Design of Sheet Pile Walls," copy attached. The transition/rotation of the soil/wall system can be estimated roughly from NAVFAC DM 7.2-62 based on soil type.
☐	☐	4.7	Items Specific to Cantilever Wall Analysis/ Design	A check of base stability or overall (global) stability should be made using generally accepted methods. A safety factor of 1.5 is the minimum allowable.
☐	☐	5.	Items Specific to Single Level Braced or Anchored	

			Walls	
☐	☐	5.1	Items Specific to Single Level Braced or Anchored Walls	Common items (I.A. through I.M.) and items II.A. through II.C. above apply.
☐	☐	5.2	Items Specific to Single Level Braced or Anchored Walls	The free-earth support method should be used as the basis of design. No moment reduction due to flexibility of the wall should be assumed.
☐	☐	5.3	Items Specific to Single Level Braced or Anchored Walls	Provide calculations to show wall the embedment depth required for rotational equilibrium about the brace or anchor level (SF=1.0 condition). Provide additional embedment length required for safety factor as in cantilever case.
☐	☐	5.4	Items Specific to Single Level Braced or Anchored Walls	Provide strut or anchor load calculations by taking moment about toe. Size sheeting as a beam with above system of forces applied.
☐	☐	5.5	Items Specific to Single Level Braced or Anchored Walls	Provide design of all bracing components (walers, struts, rakers, etc). If friction along the wall/soil interface is considered, do not reduce load on the walers by more than 20% of the waler load per linear foot as an allowance for friction.
☐	☐	6.	Multiple-Tier Braced Walls	Provide analyses for cantilever and single brace stages, strut removal, and final depth of excavation stages.
☐	☐	6.1	Multiple-Tier Braced Walls	Provide analyses for cantilever and single brace stages, strut removal, and final depth of excavation stages.
☐	☐	6.2	Multiple-Tier Braced Walls	Use generally recognized apparent earth pressure envelopes for determining multi-tier strut loads. Do not reduce strut or anchor loads to account for temporary conditions.
☐	☐	6.3	Multiple-Tier Braced Walls	Provide base stability analysis for full and partial depth of cut, as needed to final critical correlation. Minimum required safety factor is 1.5.
☐	☐	6.4	Multiple-Tier Braced Walls	An estimate of adjacent ground movement should be made (using Clough's or similar methods), accounting for stiffness of proposed wall used safety factor vs. base heave. See attached figures by Clough and by

				O'Rourke, et al for guidance.
☐	☐	6.5	Multiple-Tier Braced Walls	When analyzing overall stability of the excavation do not include friction between the wall and retained soil as contributing to stability of the system.
☐	☐	6.6	Multiple-Tier Braced Walls	Provide design for all bracing component (walers, struts, rakers, etc.).

REF: FOR THE FACT THAT DEFLECTION SHOULD BE CALCULATED AROUND POINT OF ZERO MOMENT (NOT ZERO SHEAR)

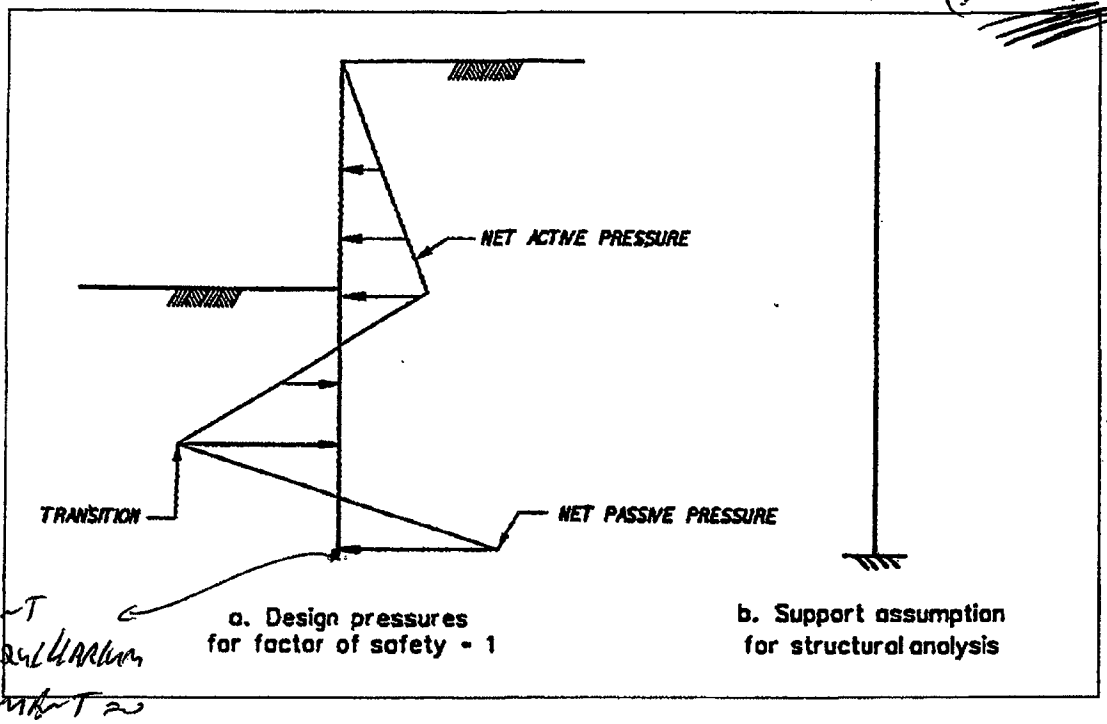

Figure 6-1. Pressures and supports for structural design of cantilever walls

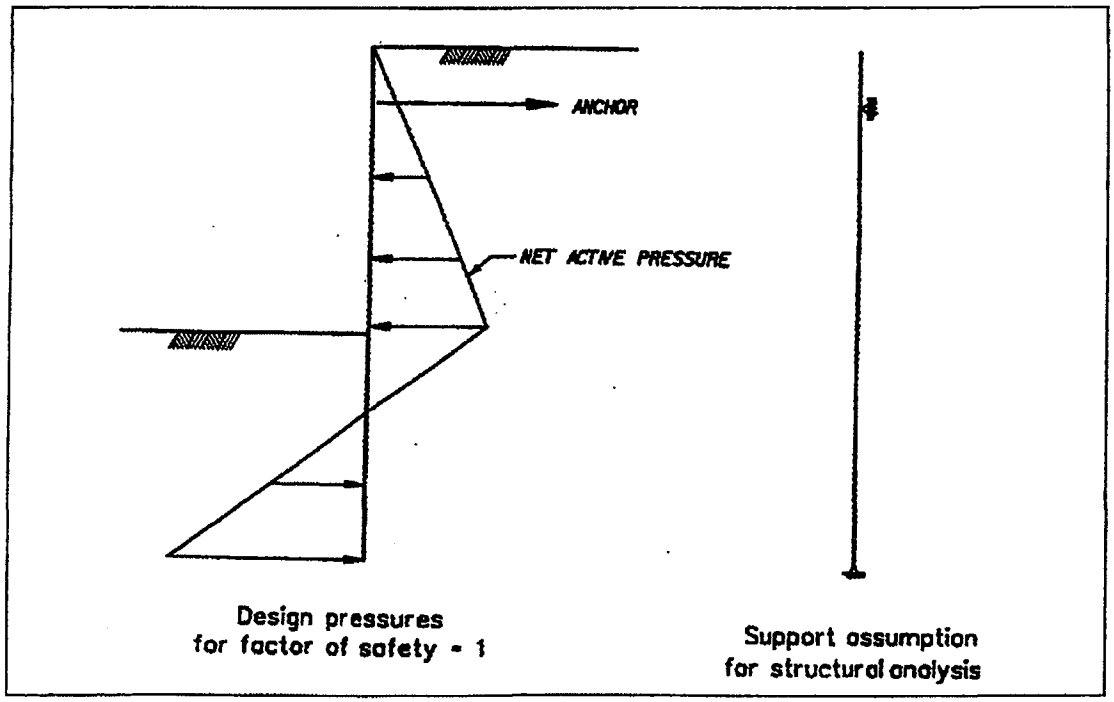

Figure 6-2. Pressures and supports for structural design of anchored walls

$f_a = 0.5 - 0.6\, f_y$
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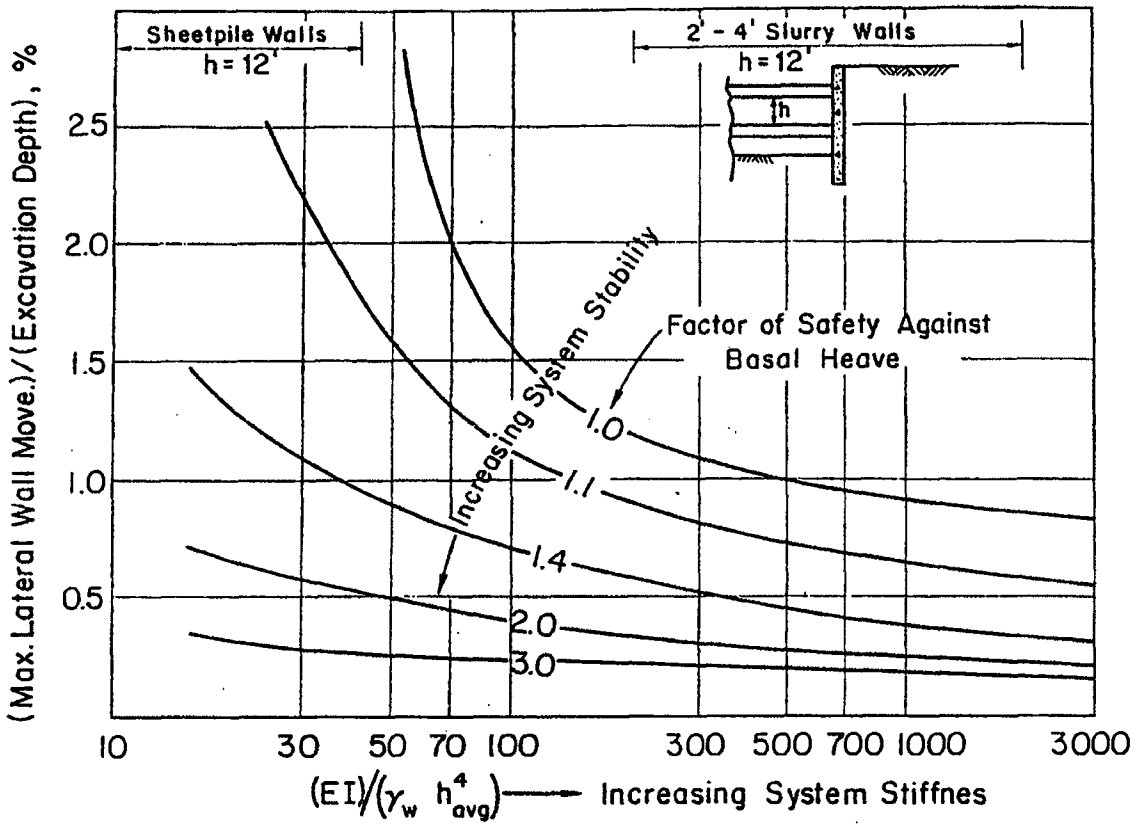

Figure 6. Theoretical Relationship Between Maximum Lateral Wall Movement, Factor of Safety Against Basal Heave and System Stiffness.

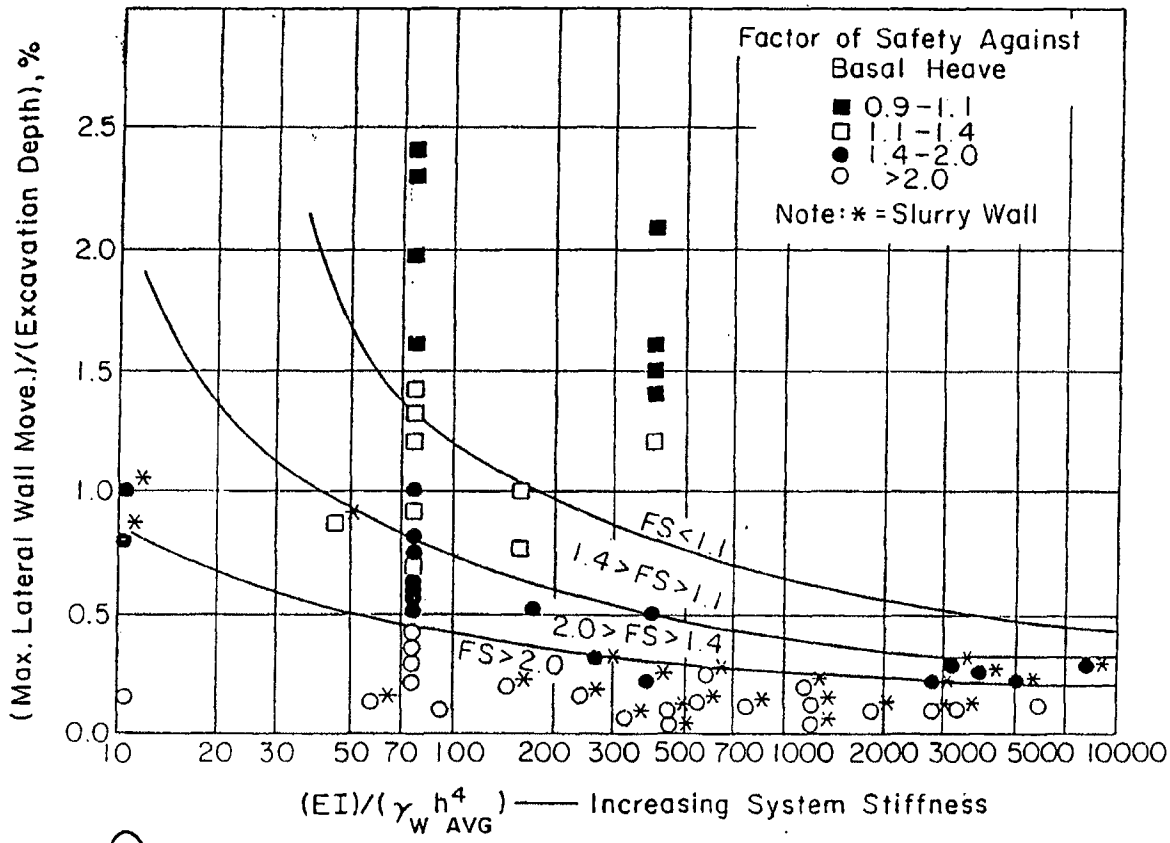

Figure 7. Comparison of Field Data and Theoretical Trends for Maximum Lateral Wall Movement.