PTI M55.1-12 Specification for Grouting of Post-Tensioned Structures
Addendum #1 June 2013

[Update your specification by changing the items as shown]

Specification	Commentary
2.1 — General This chapter covers individual grout ingredients, prepackaged grouts, and hardware. Each section is discussed individually. The ingredients of grouts intended for use in ~~bonded~~ grouted, post-tensioned~~ed~~ing ~~concrete work~~ tendons ~~can include~~ shall be limited to the following: 1. Portland cement; 2. ~~Mineral additives~~ Supplemental cementitious materials (limited to fly ash, blast-furnace slag, and undensified silica fume); 3. Chemical admixtures; ~~Aggregates;~~ and 4. Water. Supplemental cementitious materials and chemical admixtures shall not contain sulfates. Additional materials shall be permitted in Class D grouts if those additional materials and their proportions are clearly identified and if all the performance requirements for Class D grouts in the specification are met. ~~Factors influencing the quality of grout selected include the following:~~ ~~1. Cement hydration rate, as it affects working time and set time;~~ ~~2. Grout fluidity (both initial fluidity and changes in fluidity) as a function of time and temperature;~~ ~~3. Volume control;~~ ~~4. Permeability;~~ ~~5. Strength;~~ ~~6. Bleed stability characteristics; and~~ ~~7. Level of corrosion protection required for prestressing steel.~~	**C2.1 — General** Post-tensioned concrete technology developed rapidly during the 1960s. In much of the work done since that time, the majority of grouts used in construction have been a simple mixture of portland cement and water. Water-cement ratios (w/c) typically specified were between 0.47 to 0.53, with expansive and/or non-bleeding admixtures sometimes specified. In general, these grouts appear to be performing satisfactorily. However, on some projects, especially in aggressive environments such as marine and northern climates where chlorides or sulfates were encountered, these grouts did not perform as expected. Factors influencing the quality of grout selected include the following: 1. Cement hydration rate, as it affects working time and set time; 2. Grout fluidity (both initial fluidity and changes in fluidity) as a function of time and temperature; 3. Volume control; 4. Permeability; 5. Strength; 6. Bleed stability characteristics; 7. Level of corrosion protection required for prestressing steel; and 8. Segregation of materials after mixing.

PTI M55.1-12 Specification for Grouting of Post-Tensioned Structures
Addendum #1 June 2013

[Update your specification by changing the items as shown]

Specification	Commentary
2.2 — Portland cement Portland cements meeting the requirements of ASTM C150/C150M shall be used in the grout. Either Type I or Type II cements shall be used. Type II cements shall be selected for those instances in which a slower release of heat of hydration is desired. Cement shall have a Blaine value between 300 and 400 ~~380~~ m^2/kg (3.85 and 5.14 ~~4.88~~ yd^2/lb). Blended cements conforming to ASTM C595/C595M can be used if compatible with the other ingredients of the grout.	**C2.2 — Portland cement** Oil well cements, as classified and specified by the American Petroleum Institute (API) specifications, could also be considered for use in the grouts used in deep hole applications greater than 300 ft (91.4 m) where certain sulfate resistance characteristics or long setting time requirements under higher temperatures and higher pressures are desired. ASTM C595/C595M may be used providing they do not contain ground calcium carbonate, which will extend setting time and enable this filler to rise to the surface with the bleed water in fluid mixtures, reducing the pH and cementing qualities of the paste. While some blended cements provide improvement in the microstructure of the paste pores, extended setting may be encountered with these types of materials leading to extended bleeding, especially in cooler temperatures. ~~ASTM C845 (Type K) can also be considered, but special attention should be given to the effects of admixtures influencing its properties of expansion and the time and level of maximum expansion at which the desired expansion develops. These cements have been successfully used in oil well applications.~~

PTI M55.1-12 Specification for Grouting of Post-Tensioned Structures
Addendum #1 June 2013

[Update your specification by changing the items as shown]

Specification	Commentary
2.3 — ~~Mineral additives~~ Supplemental cementitious materials	**C2.3 — ~~Mineral additives~~ Supplemental cementitious materials**
~~Mineral additives~~ Supplemental cementitious materials permitted to be used in modifying the properties and behavior of grouts are: 1. Fly ash (Class C and Class F), conforming to ASTM C618; 2. Slag cement conforming to ASTM C989/ C989M. Only Grade 120 slag shall be specified for use in PT grouts; and 3. Silica fume conforming to ASTM C1240. Only undensified silica fume shall be permitted. ~~Densified silica fume shall not be used.~~ No other supplemental cementitious materials shall be added.	All three materials are widely used in portland cement concretes. The potential benefits of these ~~mineral additives~~ supplemental cementitious materials used in grouts for bonded, post-tensioned work include: 1. Reducing the maximum temperature developed during the cement hydration reactions; 2. Increasing long-term strength; 3. Decreasing permeability of the grout with the effect of slowing down the rate of chloride ion migration; and 4. Reduction of bleeding. While ~~mineral additives~~ supplemental cementitious materials have potential benefits, their properties and interactions with other grout constituents can differ significantly from source to source. Formulations developed with these additives should carefully consider chemical admixtures' interactions and potential changes in expected properties (refer to References 6 and 7 for details). Tests have shown that powdered, dry-compacted silica fume does not disperse and will agglomerate in fluid grout mixtures, even with high-range water-reducing admixtures. This condition does not occur in concrete mixtures due to the fine and coarse aggregates, which break up the agglomerated particles due to attrition in the stiffer mixes. Undispersed dry silica fume may be a potential source for alkali aggregate long-term reaction sites.[8]

PTI M55.1-12 Specification for Grouting of Post-Tensioned Structures
Addendum #1 June 2013

[Update your specification by changing the items as shown]

Specification	Commentary
2.4 – Chemical admixtures	**C2.4 — Chemical admixtures**
Chemical admixtures used in grout shall conform ~~with~~ to ASTM C494/C494M and as permitted in Sections 2.4.1 through 2.4.5. Compatibility with the cement, ~~mineral additives~~ supplemental cementitious materials, and other chemical admixtures being considered shall be established during the grout trial mixes (~~refer~~ Refer to Section 4.6). (Note: No change to 2.4.1 through 2.4.5.)	The functions provided by chemical admixtures include: 1. Set control; 2. Water reduction; 3. Air-entrainment; 4. Bleed control; 5. Volume control; 6. Corrosion inhibition; and 7. Pumpability. Chemical admixtures for portland cement concrete are typically liquids (less frequently, dry powders) that are added to concretes and mortars in small amounts to influence fresh and hardened properties and characteristics of the material.
2.5 — Aggregates	**C2.5 — Aggregates**
Aggregates and inert fillers shall be permitted to be used in Class D grouts if those additional materials and their approximate proportions are clearly identified and if all the performance requirements in the specification for Class D grouts are met. Aggregates, if used in Class D grouts for post-tensioned construction, shall have a maximum size of 1 mm (0.04 in.) to facilitate movement of the grout through the duct and provide total encapsulation of the prestressing elements. They shall meet all the requirements of ASTM C33/C33M, except for gradation.	Historically, aggregates have not been widely used in grouts for bonded, post-tensioned construction. Aggregates defined under “Concrete Fine Aggregates” in ASTM C33/C33M and “Masonry Fine Aggregates” under ASTM C144 typically have gradation requirement standards that are too coarse to be used in PT grouts. The function of aggregates in the grout material would be to reduce its permeability and to improve its volume stability by reducing drying shrinkage. In as much as aggregates can make a positive contribution to the overall performance of these grouts, their use should be considered very carefully.