U.S. ARMY CORPS OF ENGINEERS
MIDDLE EAST DISTRICT
WINCHESTER, VIRGINIA

DESIGN CHECKLIST

1. The checklist is intended to serve as a convenient guide in design development as well as the final checking of plans and specifications for construction projects. Its main usefulness for this purpose is that it points out errors and discrepancies that frequently occur. It is not intended to be all-inclusive, but if used conscientiously, it will serve to eliminate many of the design deficiencies, which have been found in past construction projects.

2. The checklist will be utilized and completed for each project and will be submitted with the final Design Analysis. It will then be utilized by the Middle East District (MED) for review of the completed design.

3. Each item in the checklist must be marked to indicate that the item has been examined by inserting a check mark in the space provided for the reviewer's notes. If an item is not applicable, the letters "NA" should be inserted in this space. If an entire section is not applicable, this may be noted at the beginning of each section.

4. Brief explanatory notes may be inserted in the space provided for reviewer's notes when appropriate. For example, when checking equipment space requirements, the manufacturer of the type of equipment used to check this item may be inserted in this space. Also, if special reasons exist for not complying with an item, an explanation must be inserted.

5. It is important that review comments be scrutinized for compliance as part of the checking procedures.

FINAL STRUCTURAL DESIGN CHECKLIST

PROJECT NAME

DISCIPLINE_____DATE_____ FINAL REVIEW

REVIEWER_____DRAWINGS REVIEWED

EVERY ITEM WILL BE REVIEWED AND NOTED FOR COMPLIANCE (C), OR NON-APPLICABILITY (NA).

SECTION 6 - STRUCTURAL

ITEM NO.	ITEM	CHECK
A	**GENERAL - Check**	
1.	The review comments have been incorporated in preceding stages of design.	
2.	The design calculations are consistent with the geometry of the final plans.	
3.	Insure design calculations are neat and the results are clearly shown. Both must be readily understandable to the reviewer. Do not omit steps and references. Show all calculations have been reviewed by another engineer.	
4.	Ensure the half-size drawings are legible and uncluttered at the scales specified for each section, plan view, and detail. Also, provide scale legends to all the scales used for each sheet.	
5.	The applicable Force Protection measures in DoD Antiterrorism Standards for Buildings have been applied, and the design recommendations from Omaha Protective Design Center have been incorporated. The Antiterrorism/Force Protection standards include the latest UFC 4-010-01 and USCENTCOM Force Protection Construction Standards.	
6.	North arrows are provided on plan views.	
7.	Section cuts are labeled and oriented correctly. Detail references	

coordinate with the detail drawings.

8. The architectural, mechanical, or other disciplines do not conflict with the structural plans or specifications. Special attention was paid to:

    a. Locations of ductwork, wall chases, etc.

    b. Dimensional correctness and architectural gridlines coincide with the structural drawings.

    c. Headroom clearances

    d. Beams and columns protruding horizontally and vertically into stairwells, and other interior spaces.

    e. The differing top of interior masonry wall connection details.

    f. Structural walls and the wall material are coordinated with the architectural drawings.

    g. The slope of the roof has been accounted for in the design of the roof beams at the gable ends.

ITEM NO.	ITEM	CHECK

B STRUCTURAL NOTES - Check

1. Structural notes are adequate for each building and structure.

2. The current codes and design guides are listed including the current IBC code, ASCE 7, and UFC 3-301.

3. The following items shall comply with the current IBC code, ASCE 7, and UFC 3-301, and be provided on the contract drawings for **EACH** individual building or other structures considered:

    a. Service live loads and other special loads for cranes, wheel loads, mechanical and electrical equipment loads, etc.

    b. Wind speed, exposure category, and importance factor.

c. Earthquake parameters Ss and S1.

c. Allowable stresses for each material utilized.

d. Maximum allowable soil bearing pressure using service loads. If actual soil bearing pressure has not been obtained, then the *assumed* maximum allowable soil bearing pressure using service loads is listed.

e. List the type of structural system used (e.g. special reinforced concrete frame, ordinary reinforced masonry shear walls) and the response modification coefficient, R, per current ASCE 07.

ITEM NO.	ITEM	CHECK

C PERTINENT DESIGN FACTORS - Check

1. Design of below grade structures, tunnels, trenches, pits, etc., considered uplift and other effects due to groundwater.

2. Deflection (including long term deflection) was considered and camber provided where required. These items should be closely checked where long spans are involved. The deflections of the beam and/or slab were calculated if they did not meet the minimum depths required by section 9.5 in ACI.

3. The sizes of materials utilized are commonly available and within stock lengths. If materials (including reinforcing steel), members, or assemblies exceed stock lengths or handling and transportation limitations, splices are specified and detailed.

4. The structure and its parts can be built as detailed when materials, fabrication practices, usual tolerances and discrepancies, construction techniques, and sequence of operations are taken into account.

5. The height of all columns and walls is provided. The drawings clearly show the spacing between supporting elements so the design of the structural components can be easily verified.

6. The design is complete, i.e. that a design for all structural components has been included.

7. Auxiliary work such as chimneys, underground tanks, cooling tower foundations, transformer pads, machinery and equipment supports, and utility pits and covers, are located and properly detailed.

ITEM NO.	ITEM	CHECK

D FOUNDATION AND STRUCTRUAL FRAME - Check

1. Walls are designed to resist lateral loads due to backfill materials and potential surcharges.

2. Pipe sleeves are provided in foundation walls where required for penetrations.

3. The bottom of footing elevations has been checked against boring logs to avoid unnecessary excavation into rock.

4. Waterproofing of walls or floors is provided as required.

5. The elevation of the top of all footings is shown.

6. Adequate wall sections and details are shown on the drawings.

7. Footings are deep enough so dowels extending down into them will provide enough embedment for tension development.

8. Structural engineer has coordinated with the civil and geotechnical engineer to ensure the manner of establishing footing depths is consistent with existing topography, and existing site conditions with respect to any required clearing and grubbing, demolition, removal or accommodation of existing utilities and other construction. The establishment of footing depths is consistent with respect to new or existing construction such as pits, trenches, adjacent fuel oil tanks, or other underground installation.

9. Structural engineer has coordinated with the geotechnical engineer to ensure other recommendations of the soils report have been complied with, such as minimum footing depth, magnitude of passive pressures, etc.

10. The finished grade symbol and/or label is shown in appropriate sections.

11. Stepped wall footings between different levels are provided.

12. Slabs-on-grade do not bear directly on the footings.

13. A capillary water barrier, waterproofing, or vapor barrier membrane is shown where required.

14. The sub-grade is shown for the different conditions in section or details. Structural engineer has coordinated with the geotechnical engineer concerning the sub-grade, and the sub-grade is noted on the drawings to meet the requirements in the specifications concerning compaction, etc.

15. The top of foundation walls is defined at all points around the building.

16. Per ACI 7.10.5.6 where anchor bolts are placed in the top of columns or piers, the bolts shall be enclosed by stirrups distributed within the top 125 mm (5") of the top of column or pier. The stirrups shall consist of at least (2) 12 mm rebar or (3) 10 mm rebar.

17. A detail or section is provided to show how the crosstie beams or hairpins are connected to the foundation. (Especially important when large horizontal forces/thrusts are being resisted in pre-engineered steel buildings, etc…)

18. Show how the bases of columns and walls are connected to the foundation with details and sections.

19. A detail or section is provided to show how the columns and/or walls are connected to the 1^{st} floor, 2^{nd} floor, etc.

20. A detail or section is provided to show how the columns and/or walls are connected to the roof. If a roof parapet exists, the parapet connection to the roof and roof beams or walls is provided.

21. The recommended 150 mm minimum thick slab-on-grade is provided especially in locations where quality control and durability are issues.

22. The exterior walls are adequately designed to meet the in-direct fire of anti-terrorism/ force protection requirements.

23. In regions of high risk of incoming mortars, one of the approved MED roof assemblies is used for roofs needing to meet the anti-terrorism/ force protection requirements.

24. The foundation system has been designed with regard to possible differential settlement upon supported elements.

ITEM NO.	ITEM	CHECK

E CONCRETE - Check

1. The special additional information and criteria due to the climate in the Middle East listed in item #2 below has been added into the concrete specification sections 03 30 00, and 03 31 00.00 10.

2. Along with other criteria, the concrete specifications shall have the following information:

a. Concrete shall be composed of cementitious material, water, fine and coarse aggregates, and admixtures and shall be in accordance with the provisions of the ACI 318.

b. All structural concrete shall have cylinder compressive strength of 28 MPa (4000 psi) minimum at 28 days.

c. Concrete shall be comprised of ASTM C 150, Type I or V cement.

d. Concrete shall consist of 3.5 % to 4.5% air entraining admixture in Afghnaistan.

e. Concrete shall contain a high-range water-reducer, HRWRA, in accordance with ASTM C-494, Type "F" or Type "G". The dosage of the HRWRA shall be determined during mixture proportioning study.

f. The cementitious material shall consist of Portland cement with a 7.0 to 9.0 percent by mass replacement of cement by silica fume. Silica fume shall comply with the requirements of ASTM C1240-60a.

g. The cementitious material content shall not be less

than 390 kg/cubic meter. The mixture shall also have a water-cementitious material ratio of 0.45 or less.

h. Concrete shall have maximum water-soluble chloride ion content for corrosion protection of 0.15 percent by mass of the Portland cement.

i. Hot weather requirements shall comply with the recommendations of the current ACI 305R.

j. Concrete shall not be placed in cold weather when ambient temperature is less than 5 degrees C or when concrete temperature is less than 10 degrees C. Heating of the mixing water or the aggregates will be required to regulate the concrete placing temperature in cold weather. Protective measures shall be taken if freezing temperatures are anticipated before the expiration of the specified curing period.

k. All concrete shall be cured for a minimum of 7 days.

l. Where aggregates are alkali reactive, as determined by Appendix XI of ASTM C1260-05a, cement containing less than 0.60 percent by mass alkalies (as Na2O equivalent) shall be used.

m. Concrete members at or below grade shall have a minimum concrete cover over reinforcement of 75 millimeters.

n. Reinforcing steel shall be deformed bars conforming to ASTM A 615M-05, grade 60, and welded wire fabric shall conform to ASTM A 185M-07.

3. Type I or V cement with silica fume, air entrainment, and a high range water reducing admixture has been specified where concrete will be exposed to soils or ground water having high sulfate content.

4. Details of concrete columns show architectural configuration and masonry control joint provisions for all cases.

5. Concrete members are properly sized and detailed to provide required cover and spacing between bars at bar splices and connections.

6. Reinforcement placement in beams including grade beams, girders, joists, and slabs is detailed to show location, bends, extensions, rebar sizes, splices, anchorage, stirrup sizes, stirrup spacing, stirrup locations, and stirrup/tie configurations.

7 Reinforcement placement in columns including piers and pilasters are detailed to show location, bends, extensions, rebar sizes, splices, anchorage, stirrup sizes, stirrup spacing, stirrup locations, and stirrup/tie configurations.

8. A bar bending diagram is added where required for clarity.

9. For better quality control reasons, the recommended straight top and bottom reinfocement has been used in the beams and slabs as opposed to bending the bars to economize the design.

10. In one-way continuous floor and roof slabs, top bars have been provided transverse to beams, joists, girders, and walls which are perpendicular to the slab span. The slab thickness is sufficient to provide reinforcing in top and bottom of slab in both directions.

11. Depressed areas in slabs, when required for setting beds or insulation, have been indicated and reinforcement placement for this condition is clearly detailed.

12. Concrete cover for reinforcement is shown in notes for all members and conditions. In areas close to the sea, additional cover or other provisions have been provided to protect reinforcing bars against attack by salt-laden moisture.

13. Additional reinforcement is provided and clearly detailed around openings in concrete walls and slabs.

14. Exterior platforms, door pads, and patios are sloped to drain away from the building.

15. Floors are pitched to drains and pit floors pitched to drains or sumps. (Note: In some cases, trench floors will also be pitched).

16. Column center dimensions, wall thickness, and other necessary dimensions are shown.

17. Roof structure is adequate to support equipment to be installed, and the curbs or pads to support the equipment. Special attention has been paid to areas with large concrete pads like the ones supporting large satellites, etc. Also, large slab openings have

been framed around with intermediate roof beams.

18. Potential maintenance and replacement loads have been considered for roof and other levels.

19. All slab designations are noted.

20. Splice lengths for all sizes of rebar used have been shown or tabulated.

21. All beam elevations are clearly indicated and all beam offsets are shown.

22. The following schedules are shown, if required:

    a. Footing schedule.

    b. Grade beam schedule.

    c. Pile cap schedule.

    d. Lintel schedule.

    e. One-way and two-way concrete slab schedule.

    f. Concrete beam schedule.

    g. Column schedule.

23. The column schedule and detail show all story heights, splice points, and the top and bottom of all columns with relation to some given floor elevations.

24. When flexural members act as part of a primary lateral load resisting system, check the bottom bars will develop the yield stress in tension at the beams ends. (See ACI 318).

25. Insure that the setting bed for tiled areas consisting of quarry or terrazzo tile are deep enough to accommodate embedded items such as conduit and construction tolerances.

26. Insure that concrete water storage tanks are provided with a watertight membrane liner as part of the system. The technical coordinator or leader of the design team should be notified to ensure this liner is on the drawings and described in the

appropriate specifications.

27. For primary reinforcement, the recommend #12 rebar minimum has been used. (Typically #10 rebar only used for lateral reinforcement elements like stirrups, hoops, ties, etc…)

28. The reinforcing provided meets the minimum percentage and temperature requirements of ACI. Also, the reinforcement does not exceed the percentage of steel allowed per ACI. Attention was made to ensure rebar spliced in standard columns does not exceed 8%, or exceed 6% for special moment frames.

ITEM NO.	ITEM	CHECK
F	**JOINTS - Check**	

1. Insure that expansion joints through elevated floors, walls, roof, etc., are clearly detailed.

2. The maximum spacing of 150 feet (115 feet for EAF Project) between expansion joints has been observed for concrete structures. If the spacing has been exceeded, supporting analysis has been provided. Isolation or expansion joints have been used because of L-shaped, U-shaped, or other irregularly shaped buildings.

3. All joints required to build the structure are shown.

4. Waterstops are provided in joints below grade when water could enter into a usable space.

5. The types and locations of control, construction, and expansion joints are shown, and the layouts are designed so the joints will function as intended. The details of control, construction, and/or expansion joints are shown separately.

6. The distance between two crack control joints for slabs on grade does not exceed the 25 foot limit.

7. The control joints are at least ¼ the depth of the slab.

ITEM NO.	ITEM	CHECK
G	**MASONRY - Check**	

1. Coursing of masonry walls and partitions shall be coordinated between architectural and structural drawings to avoid cutting blocks, especially the top course of block.

2. Control joints are clearly located and fully detailed for each condition, type of construction, and finish.

3. Horizontal joint reinforcing is provided.

4. Horizontal joint reinforcement is used in the horizontal masonry mortar joints unless bond beam type construction preferred. (Rebar used in the mortar joints is usually too large. For normal mortar joint thicknesses of 10 mm, proper clearance can't be achieved around the rebar to ensure proper bonding. In remote locations, 6 mm rebar can be used in mortar joints, if horizontal joint reinforcement not available.)

5. The location, size, and amount of extra reinforcement is shown for the concrete masonry units at or near openings.

6. All lintels are provided.

7. All masonry pilasters are of sufficient capacity for loads applied.

8. The design criteria for crack control have been followed where applicable. The maximum spacing of 7.2 meters for control joints has been provided.

9. For masonry design, the maximum effective width for the wall stiffeners compression flange shall be limited to the least of six times the wall thickness, or the bar spacing, or 72” as determined by minimum reinforcement requirements dictated by wind or seismic loads.

11. In concrete frame structures, a detail has been provided showing the method of supporting the masonry wall. For infill walls and other non-loadbearing wall systems, the top of the wall shall be free to move in plane relative to the framing beams. Such walls shall be designed to span in both the horizontal and vertical directions assuming a partial fixity at the wall base and hinged or simply supported at the wall edges or ends.

12. Provided design reinforcement for masonry walls and masonry lintels. Verified the structural masonry walls are designed to meet the out-of-plane seismic forces of section 12.11, ASCE 7-05.

13. Provide design reinforcement for non-structural masonry walls. Verify that the non-structural masonry walls are designed to meet the out-of-plane seismic forces of section 13.3, ASCE 7-05.

14. No masonry is shown in direct contact with the soil or used below grade. (If it is necessary to use CMU below grade, all cells shall be fully grouted, and an approved protective waterproof barrier is provided on all masonry surfaces in contact with natural ground.)

15. Information is provided showing how the masonry walls are laterally anchored with ties on the structural sheets.

ITEM NO.	ITEM	CHECK

H STRUCTURAL STEEL - Check

1. The type and size of all fasteners for connecting structural steel is shown or noted.

2. The type, size, and length of all welds are shown utilizing standard (AWS) welding symbols.

3. Connections of steel members and joists to concrete are detailed so that they can be erected independently, providing positive bearing on concrete and taking into account the usual variations in concrete from plan dimensions.

4. Check that all beam sizes are shown.

5. The loads, including shears, moments and axial forces to be resisted by individual members and their connections are provided.

6. Hangers and supplementary framing for monorails or other overhead installations are detailed.

7. Miscellaneous metal items are adequately detailed.

8. Covers and grating are properly sized for possible loads, particularly where accessible to wheel loads.

ITEM NO.	ITEM	CHECK

I PRECAST CONCRETE - Check

1. Connections for precast concrete elements are adequately designed and detailed on the structural drawings.

2. Design of connections consider movement, caused by thermal expansion and contraction, live loads, wind, settlement, creep, yielding, etc., acting upon bolts and plates of the connection.

3. Details of connections include note that indicates correct procedure for installing bolts of connection designed for thermal expansion and contraction.

4. Connections shall be detailed in accordance with procedures outlined in the latest edition of the following manuals:

    a. MNL-120; "PCI Design Handbook.

    b. MNL-121; "PCI Manual for Structural Design of Architectural Precast Concrete".

    c. MNL-122; "Architectural Precast Concrete".

    d. MNL 123; "PCI Manual on Design of Connections for Precast Prestressed Concrete".

    e. MNL-124; "PCI Design for Fire Resistance of Precast Prestressed Concrete".

5. Include notes on tolerances to be allowed.

6. Precast concrete shall not be used in structures that do not meet the USCENTCOM minimum required stand-off distance to a controlled perimeter fence line.

ITEM NO.	ITEM	CHECK

J METAL BUILDING SYSTEMS - Check

1. Bracing types and locations are shown; or restrictions are covered by notes.

2. That masonry control joints in skirt walls are shown and coordinated with stucco control joints on Architectural Drawings.

3. The special additional information and criteria due to the climate in the Middle East has been added into metal building specification section 13 34 19.

4. Differential deflection of metal building system and other construction has been considered. Special attention has been paid to the potential allowable movement allowed by the metal building frame versus the masonry veneer.

ITEM NO.	ITEM	CHECK

K PROPRIETARY MATERIALS AND EQUIPMENT

INITIAL To the best of my knowledge, the specifications and drawings do not include any proprietary or sole source materials except for the following approved items: