OBJECTIVE SHEET

SUPERFLAT FLOORS

8

INTRODUCTION

Although flat floors have always been the goal of cement masons, concrete slabs have never been truly flat. For many years this was not a problem because small variations in floor surface were seldom noticed. However, with the advent of VNA (Very Narrow Aisle) technology in warehouses this began to change. VNA technology was an effort to conserve space and storage costs with the use of high lift trucks operating in very narrow spaces. Suddenly the concept of flat floors became very important as small variations in floor surface could cause accidents or make working conditions difficult and hazardous. Robotic equipment and high-speed forklifts working with cargo at increased heights required a smoother surface than those traditionally accepted as flat.

Advances in measuring, specifically the development of the profilograph, now allow the accurate measurement of variations in concrete floors. The development of the F-number system has given cement masons a system of measurement to ensure uniform quality in superflat floor construction, and more powerful tools now allow for more accurate finishing and grinding of superflat floors.

FOCUS ASSIGNMENTS

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1. Watch the video “An Introduction to the F-Number System” from FACE Construction Technologies, Inc.

2. Write a one-page summary of what you learned from the videotape. Include any thoughts you have on how the F-number system might enhance not only superflat floors, but common floors as well.


Employability


Critical Thinking

UNIT OBJECTIVE

After completing this unit, you will show the following competencies by mastering the activities on the Job Sheets and by scoring at least 85% on the Written Test.

SPECIFIC OBJECTIVES

1. Classify values in the F-number system.
2. Define terms associated with the F-number system.
3. Match F-numbers to tolerances.
4. Match finishing equipment to the F-numbers they can achieve.
5. Describe equipment used to measure F-numbers.
6. Identify properties of concrete design that affect superflat floors.
7. Describe tools used on superflat floors.
8. Describe the role of power trowels in finishing superflat floors.
9. Describe joint cutting and curing for superflat floors.
10. Explain proper subgrade preparation for superflat floors.
11. Identify proper form setup for superflat floors.
12. List factors to consider when placing concrete for superflat floors.
13. Set up a slab for a superflat floor. (Job Sheet 1)
14. Place and finish a slab for a superflat floor. (Job Sheet 2)

SUPERFLAT FLOORS

OBJECTIVE 1

Classify values in the F-number system.

The F-number system was originally developed by The Face Companies in the 1970's in response to a request by a client for an extremely flat floor. At the time there was no reliable system for measuring the flatness of a floor or for determining how flat a floor needed to be finished. Also, the "straightedge" measuring system used at the time was confusing and unreliable for the following reasons:

- The standard acceptable variance was ⅛" per 10 feet of floor. This could be misinterpreted to mean ⅛" above or below an imaginary plane, making the true variance ¼".

- Even if it was agreed that ⅛" meant a single envelope of this size, the concept of flatness was still not truly incorporated.

  EXAMPLE: If a floor has 10 variations of ⅛" within 10 feet is it really flat? Under the old system of measurement this was acceptable.

- Measurement of floors was unreliable. Modern measurements show that industrial floors have an average variance envelope of ⅝".

To correct these errors, a reliable system of measurement and numerical expression was needed for floors. This would ensure that contractors and owners alike would be in agreement on how flat and level a floor should be and what values would indicate that this had been achieved. To create this system, the following measurements were developed:

F_F — this number indicates the flatness of the floor. In other words, how large are the variations in the surface of the floor? This value is used for construction of all concrete flatwork.

- The higher the F_F-number, the smoother the floor

- Measurements are analyzed every two feet to determine this value

- F_F-numbers are most affected by finishing

  ✔ **NOTE:** F_F values are more important for traffic — bumps, vibrations, etc.

F_L — this number indicates floor levelness. In other words, how level is the floor from end to end?

- The higher the F_L number the more level the floor is
- Measurements are analyzed every 10 feet to determine this value
- F_L numbers are most affected by the method of strike off and forming

  ✔ **NOTE:** F_L values come into play in certain special applications such as ice rinks, basketball courts, etc.

Typical F-Numbers		
F_F	F_L	Floor Profile
13	10	Poor Quality
20	15	Average
30	20	Flat
50	30	Very Flat
100	50+	Superflat

OBJECTIVE 2

Define terms associated with the F-number system.

WORDS YOU SHOULD KNOW	
corrective grinding	minimum grinding, in wheel tracks only, to correct areas out of tolerance

- **S.O.V.**— Specified Overall Value; the combined values for F_F (flatness) and F_L (levelness) that must be obtained at the completion of all concrete floor placements at a given elevation.

  ✔ **NOTE:** As each slab is poured it is measured separately. When the project is completed, all numbers for the individual slabs are combined to get the S.O.V.

- **M.L.V.** — Minimum Local Value; the lowest acceptable measurement (F-numbers) anywhere on the floor.

✔ **NOTE:** Failure to meet the M.L.V. usually results in remedial work like grinding, re-topping, or removal and replacement of that portion of the floor. If M.L.V. numbers are met but not S.O.V. numbers, the standard practice is for a portion of the contract value to be returned to the owner.

- **Defined Traffic Floor** — designated for superflat floors where the traffic area remains the same constantly, such as floors for use by VNA (Very Narrow Aisle) lift trucks, which repeatedly move across the same paths. (Figure 1)

FIGURE 1

- **Random Traffic Floor** — a floor without defined traffic paths, where movement may occur in any direction across the floor.

OBJECTIVE 3

Match F-numbers to tolerances.

✔ **NOTE:** The old method of determining tolerances by using a ten foot straight edge does not directly correlate to F-numbers. However, these might be considered rough equivalences.

- F_F 25 is roughly ± ¼ inch in 10 feet

- F_F 50 is roughly ± ⅛ inch in 10 feet
- F_F 100 is roughly ± 1/16 inch in 10 feet

OBJECTIVE 4

Match finishing equipment to the F-numbers they can achieve.

Equipment	F_F	F_L
Bullfloat	<25	<15
Wet Screed	25	15
Vibratory	35	25
Laser Screed	50	60

OBJECTIVE 5

Describe equipment used to measure F-numbers.

- **Profilograph** — a measuring device that is a vehicle simulator. The profilograph is designed to simulate the movement of VNA (very narrow aisle) lift trucks as they move across a defined traffic floor. VNA lift trucks always travel in the same path after the storage racking system is set up, so the profilograph's wheel base is set to the same track as the VNA truck. It is able to record the floor pattern just as the wheels of the VNA truck will feel it, and assign F-numbers to the surface. (Figures 2 and 3)

FIGURE 2

FIGURE 3

- **Dipstick Floor Profiler** — a device for measuring random traffic elevation across a floor. (Figure 4)

FIGURE 4

- **Inclinometer** — measures F_F-numbers on ramps and transitions.

✔ **NOTE:** All superflat floors are not level.

OBJECTIVE 6

Identify properties of concrete design that affect superflat floors.

- **Aggregate size** — superflat floors require a wider range of stone sizes, focusing on the middle range of aggregate sizes with a high percentage of large-size stones. Any aggregate used for superflat floors should lead to uniform distribution of sand and cement and reduce excessive bleed water.

  ✔ **NOTE:** The aggregate preferred for superflat applications is often referred to as blended aggregate. The wide range in size leaves less voids to be filled, less mortar needed, less water, and consequently, less curling.

- **Design strength** — adequate design strength should be proven by historical data from the manufacturer. New or untested mixes should always be tested for design strength on another surface before use on a superflat slab.

- **Mix** — the concrete should pump and place easily. A rocky mix is often desirable to minimize bleed water, but can be more difficult to place. This has led to the use of natural sand rather than manufactured sand to increase the workability of the mix.

  ✔ **NOTE:** A single mix design should be used for placement of superflat surfaces.

- **Set time** — should be monitored and controlled closely at the plant and on the job site. It is critical in superflat floor construction that set times be consistent.

- **Slump** — contractors have found that using on-site material testing, minimizing the use of admixtures, and strict quality control from the plant to the job site greatly enhance the uniformity of the slump.

  ✔ **NOTE:** One of the most important factors in placing concrete for superflat floors is that all concrete placed is very similar.

- **Water/Cement ratio** — contractors have found that when middle size aggregates with a high percentage of large size stone, natural sand, and concrete minimizing shrinkage are used, less water and cement are required to maintain a high degree of workability.

✔ **NOTE:** Having less fines in the mix design is very important since the surface must be reworked many times. Less fines brought to the surface means there is less chance of "stacking" during the finishing process that can greatly affect the F_F numbers.

- **Workability** — is probably the most important aspect to consider when designing mixes for superflat floors, since they must be re-worked many times.

  ✔ **NOTE:** Concrete delivery in superflat floor construction is also critical. Even a 15 to 20 minute break in pumping can lead to lower F values.

OBJECTIVE 7

Describe tools used on superflat floors.

WORDS YOU SHOULD KNOW	
laser screed	vehicular screed by which elevation is controlled through the use of a laser level
short-rodding	using a short straight-edge to strike off freshly placed concrete to the proper elevation on the edges
truss screed (vibratory screed)	mechanical device used for striking off freshly placed concrete to an established grade over a wider bay than a typical hand rod bay

- **Channel float** — used for flattening and sealing the surface after screeding. Usually a 6 ft. aluminum channel float is used for superflat floors. (Figure 5)

FIGURE 5

- **Bumpcutter** — a machined straightedge attached to handles (Figure 6)

FIGURE 6

- **Truss screed** — used for striking off concrete to an established elevation; should be pulled at as close to a constant speed as possible to minimize screed vibration (Figure 7)

FIGURE 7

- **Aluminum or magnesium straightedge** — used to rod off concrete in defined traffic floors (Figure 8)

FIGURE 8

OBJECTIVE 8

Describe the role of power trowels in finishing superflat floors.

WORDS YOU SHOULD KNOW	
break-up or lay down	the initial finishing after the slab starts to harden
float blades	blades for a power trowel used specifically for lay down
pan	circular disc which is used for of break-up or lay-down, fitting underneath the blades of a power trowel
rider	power trowel with at least two sets of spyder assemblies underneath it and controlled by a concrete finisher

✔ **NOTE:** More than ever the use of riding trowels is dominating the finishing of concrete floors, especially superflat floors.

- Pans on a riding trowel are recommended for the break-up or lay down operation, but should not begin until the slab is firm enough not to roll.
- In the beginning there should be minimal disturbance by the pans, but enough to fill holes and low spots.
- The pans should be used until they are no longer able to change imperfections on the surface.
- If a slab has color, pans should no longer be used if they begin to darken the surface.
- After pans, combination or finish blades should be used, crossing the original pattern of the pans each time to reduce surface imperfections.
- This process continues until the desired finish of the slab is attained.
- Combination blades used to float and seal after the original pans can increase FF-numbers.

  ✔ **NOTE:** This is because they reduce the chance of surface delaminations caused by the rigidity of finish blades.

OBJECTIVE 9

Describe joint cutting and curing for superflat floors.

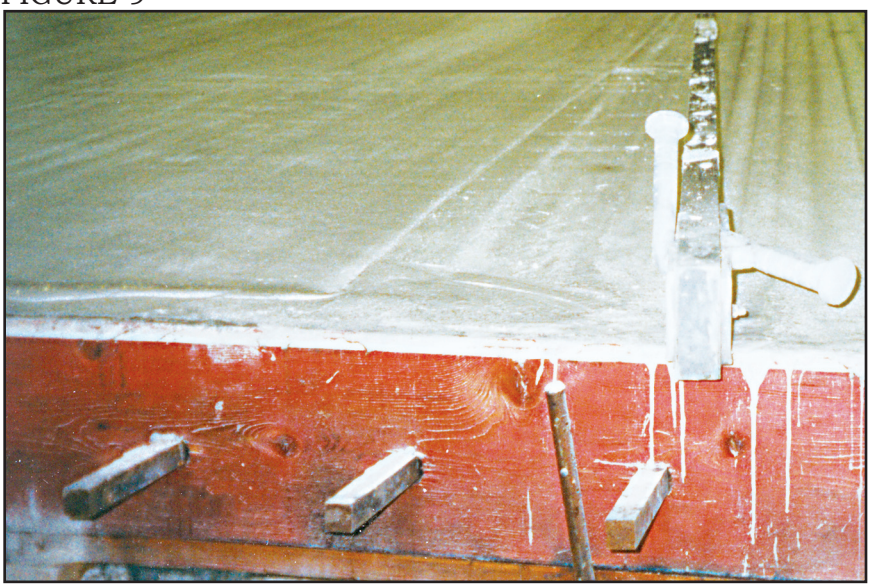
- All construction joints should be plain, vertical butt joints with sharp, square edges.

  ✔ **NOTE:** Do not tool the joints.

- In some cases it has proven beneficial to use smooth, square steel dowels with side pads. These have shown the ability to allow longitudinal and horizontal movement between adjacent slabs while still transferring vertical loads.

- Square dowels have also proven effective in reducing curling. (Figure 9)

  FIGURE 9



- Isolation joints should be created wherever possible to isolate the slab from walls, columns, or other structures. This will help to allow for differential movement in both vertical and horizontal directions.

- The preferred method for curing superflat floors is with water.

  Curing should follow these steps:

  1. Soak the slab thoroughly with water.
  2. Cover the wet slab with one sheet of burlap.
  3. Check daily for dry spots and re-wet as necessary.

  ✔ **NOTE:** The slab should be kept wet for seven full days.

OBJECTIVE 10

Explain proper subgrade preparation for superflat floors.

WORDS YOU SHOULD KNOW	
proof rolled	applying weight such as a heavy, rubber-tired vehicle to an area that has been compacted in order to check for soft spots and to provide additional compaction

- Super-flat floors must have superior subgrade preparation because of close tolerances and heavy rack loads.
- Laser grading should be done whenever possible.
- Wet silty soils should be replaced with dry granular materials.
- Eliminate the vapor barrier, if possible, to avoid excessive bleeding. Otherwise cover it with three inches of granular fill.
- If there is any question concerning the subgrade quality it should be proof-rolled before construction continues.

OBJECTIVE 11

Identify proper form setup for superflat floors.

- Accurate side forms are critical to the construction of superflat floors. Without them the desired F-numbers will not be obtained.
- Forms must be handled carefully between the shop and the job site to prevent damage.
- A 10 ft. straightedge should be used on all forms after they are erected. If any daylight can be seen, use a power hand-plane to true the top surfaces of the forms.
- During concrete placement, all forms should be constantly checked and re-adjusted as necessary to ensure proper elevation.
- All forms should be beveled to prevent changes in elevation because of twisting or leaning. (Figure 10)

FIGURE 10

- Forms should be braced well to prevent lateral movement.

OBJECTIVE 12

List factors to consider when placing concrete for superflat floors.

WORDS YOU SHOULD KNOW	
stacking	a ridge of fines left behind by a trowel machine

- Proper consolidation
- Consistent slump
- Close placement to prevent separation

  ✔ **NOTE:** Don't drop concrete from more than a couple of feet.

- Proper spreading tools
- If using a vibrating screed, spread close to grade, using only enough vibration to properly consolidate

  ✔ **NOTE:** Don't over-vibrate, this will bring too many fines to the surface, which may cause stacking.

OBJECTIVE 13

Complete Job Sheet 1.

OBJECTIVE 14

Complete Job Sheet 2.

JOB SHEET 1

SUPERFLAT FLOORS

8

Name _____Score_____

OBJECTIVE 13

Set up a slab for a superflat floor.

BASIC SKILLS


Reading


Critical Thinking


Employability

EQUIPMENT AND SUPPLIES

- Subgrade materials (if the subgrade is not pre-formed)
- Beveled forms or angle iron
- 10 ft. straightedge
- Laser or builder's level
- Personal protective equipment

✔ **NOTE:** Refer to CFR (Code of Federal Regulations) 1926 Construction Industry Safety and Health Regulations.

PROCEDURE

Yes No

❑ ❑ 1. Construct the subgrade.

✔ **NOTE:** Remember that it is critical to have a uniformly compacted, graded, and slightly dampened subgrade.

❑ ❑ 2. Construct the forms for the pour.

❑ ❑ 3. Check all forms with a 10 ft. straightedge and laser or builder's level to ensure that the tops are level.

❑ ❑ 4. Double check all form elevations prior to the pour.

❑ ❑ 5. Brace all forms to prevent lateral movement.

❑ ❑ 6. Have the instructor check your work.

❑ ❑ 7. Clean the work area and return tools and equipment to proper storage.

SKILL TEST RECORD

PRODUCT EVALUATION

Evaluator note: Rate the student on the following criteria by circling the appropriate numbers. Each criterion must receive a rating of "3" or higher to demonstrate student mastery. (See Key below.) A student who is unable to demonstrate mastery should review the material and submit another product for evaluation.

Criteria:

Safety	4	3	2	1
Use of tools	4	3	2	1
General appearance	4	3	2	1
Overall performance	4	3	2	1

AVERAGE RATING

Evaluator note: To obtain an average rating for the Profile of Training Mastery, total the points in Product Evaluation and divide by the total number of criteria. Circle the rating on the Key.

KEY

4 **Skilled** — Can perform job with no additional training
3 **Moderately Skilled** — Has performed job during training program; limited additional training may be required
2 **Limited Skill** — Has performed job during training program; additional training is required to develop skill
1 **Unskilled** — Is familiar with process, but is unable to perform job

EVALUATOR'S COMMENTS

JOB SHEET 2

SUPERFLAT FLOORS

8

Name _____Score_____

Place and finish a slab for a superflat floor.

BASIC SKILLS


Reading


Critical Thinking


Employability

EQUIPMENT AND SUPPLIES

- Pre-constructed forms ready for pouring
- Vibratory screed
- Aluminum machined rods
- Bumpcutters
- 3 to 4 ft. aluminum rods
- Concrete
- Float blades or pans
- Power trowel
- Trowel blades

✔ **NOTE:** Refer to CFR (Code of Federal Regulations) 1926 Construction Industry Safety and Health Regulations.

PROCEDURE

Yes No

✔ **NOTE:** This procedure assumes that the procedure in Job Sheet 1 has been done already, and is intended for defined traffic floors.

❑ ❑ 1. Pour the concrete in defined strips not wider than 15 ft. at a consistent rate, keeping placement close to the ground to prevent separation.

❑ ❑ 2. Use a carefully adjusted vibratory screed.

❑ ❑ 3. Follow the vibratory screed immediately with 2 or 3 sets of rodders with machined aluminum rods. Use these in a sawing motion.

Yes No

❑ ❑ 4. Follow the rodders with bumpcutters. Repeat this process many times until the slab fits the tool.

✔ **NOTE:** Most of the work done by the bumpcutters will be cutting not filling. Save excess paste for possible fills.

❑ ❑ 5. Use 3 to 4 ft. aluminum rods to rerod the edges.

❑ ❑ 6. Wait for concrete to set until ready for laydown..

❑ ❑ 7. Pan or floatblade the slab.

✔ **NOTE:** Machining is done in a counterclockwise circular pattern reducing the size of the circle by ½ each time the pattern is repeated until you have completely machined the area.

❑ ❑ 8. Quickly exit the slab.

❑ ❑ 9. Use bumpcutters.

❑ ❑ 10. Wait for the slab to harden.

❑ ❑ 11. Trowel blade in a circular pattern, going counter-clockwise the first time over to seal the concrete.

✔ **NOTE:** Some cement masons choose to run the bumpcutter one more time at this point.

❑ ❑ 12. Trowel the edges.

❑ ❑ 13. Let the slab harden.

❑ ❑ 14. Machine the slab to completion, crossing your pattern.

✔ **NOTE:** You should not be moving any significant amount of material at this point.

❑ ❑ 15. Have the instructor check your work.

Yes No

❑ ❑ 16. Clean the work area and return tools and equipment to proper storage.

SKILL TEST RECORD

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EVALUATOR'S COMMENTS