AB Fence Engineering Manual

Complete Engineering Details For The Allan Block Fence System

ALLAN BLOCK

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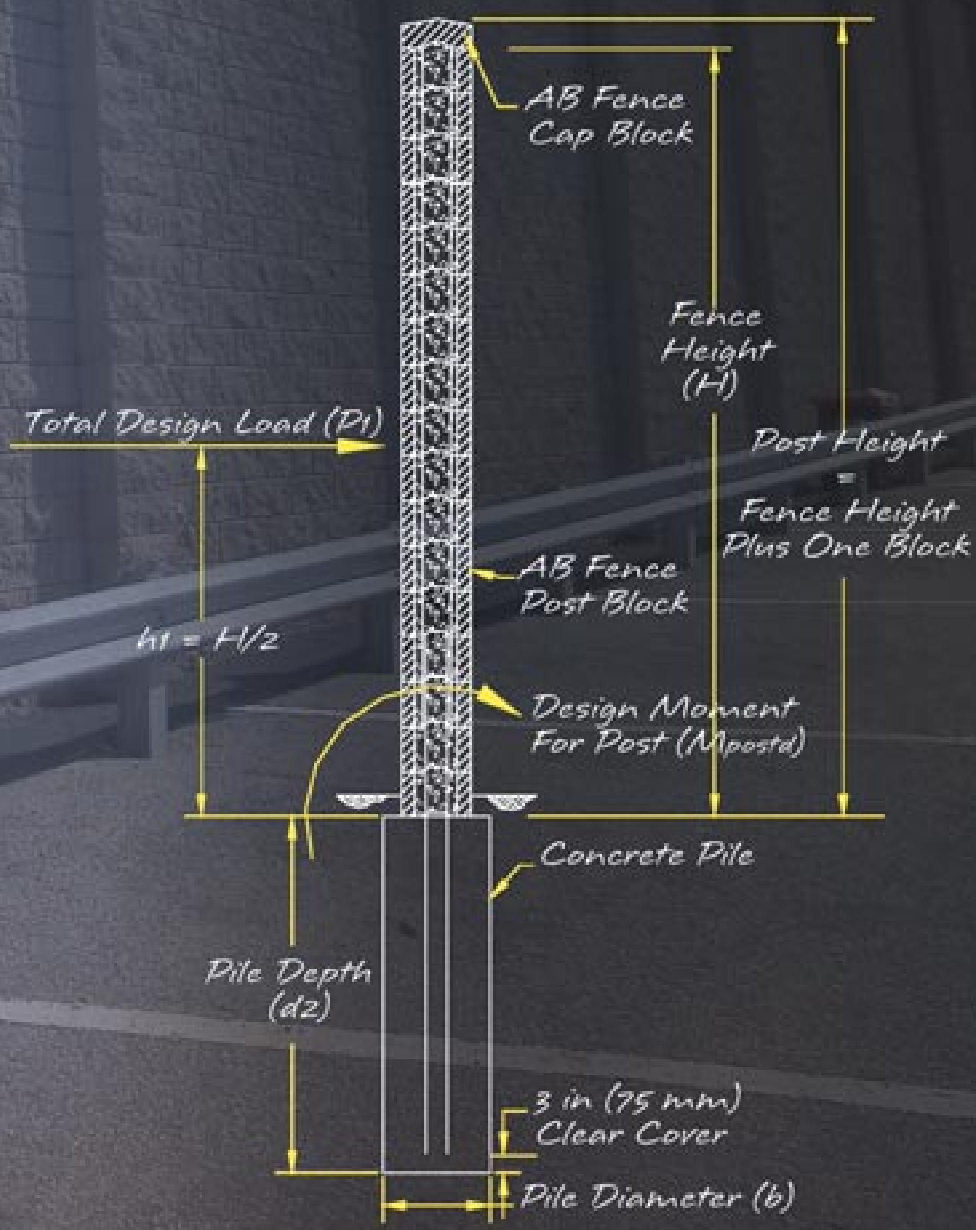

This manual represents the techniques used by Allan Block® in our engineering practice to design the AB Fence®, a fencing and sound barrier system. It is not intended as an engineering textbook. The methods we use have evolved over the course of twenty five years and continue to do so as our knowledge and experience grows.

The intended users of this manual are practicing engineers. We assume that the reader is already familiar with the basic principles of structural design of concrete systems. We encourage others to contract a qualified engineer for assistance with the design of similar structures. The example problems in this manual pertain only to the design and construction of the AB Fence® System.

AB® Post Block

The AB Fence Post block is the primary structural component of the system. Integrated into reinforced concrete piles, the AB Fence post forms the backbone of the AB Fence system.

AB® Panel Block

The AB Fence Panel block is stacked between the rigid post structures. The interlocking design of the panel block creates a strong, solid barrier that easily transfers wind and seismic loads to the post structures while remaining flexible enough in the dry-stacked units to absorb wind loads.

AB® Fence Cap

The AB Fence Cap is used to finish the top of the post and panels. The crowned configuration provides aesthetic appeal, and channels water away from the posts and panel.

AB® Corner Unit

The AB Fence Corners are manufactured for 90° transitions.

AB® Half Panel and AB® Lite Panel Blocks

The AB Fence Half Panel blocks are manufactured to eliminate the need for in-the field producing of half size panel block by cutting standard panel blocks. (not available in all locations)

AB Lite Panel

AB Half Panel

AB Half Lite Panel

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CHAPTER ONE
Concepts and Definitions

Wind Loads

The AB Fence System is designed to provide screening, security and noise abatement. It is based on a simple concept of post, panel and footing construction. The panels absorb the wind loads and transfer applied loads to the rigid post structures. The post structures then transfer the loads into a below grade footing. These three structural elements of the AB Fence System must be adequately designed to withstand the applied forces. An added benefit to the system is that while the panels are rigid enough to transfer loads they are free-floating in the notches of the post. This allows the panels to flex up and down due to frost heaves or minor site settlements. As with other fencing structures the primary overturning force comes from the wind. The following will discuss the ways wind is measured and how pressure is applied.

Measuring the Wind

The wind can vary both in terms of its speed and its direction. As a result different pieces of equipment are needed to measure these different characteristics. Wind direction is commonly determined by weather vanes or wind socks which will swing around and show which direction the wind is blowing from.

The main instrument used to measure the speed of the wind is an anemometer. The little cups on a typical anemometer (Figure 1) catch the wind and spin around at different speeds according to the strength of the wind. A recording device is used to count how many times they spin around in a given amount of time. Positioning the anemometer properly to accurately record the wind speeds is important and there are detailed standards that must be followed.

Figure 1: Typical Weather Vane and Anemometer

Wind conditions have been measured for years and the information provided in local design codes is based on decades of recorded data. By analyzing this data the average wind speed with a given return period can be obtained for a region. The "return period" refers to the most probable average wind speed that will be equaled or exceeded once during a period of time compared to the life of the fence. Thus, a shorter return period would provide lower wind speed. Longer return periods would increase the probability for higher wind speeds. For example, a 10-year average velocity will be much less than a 50-year average velocity. Allan Block has set the return period for the AB Fence Design methodology to 50 years.

Wind Pressures

The wind speed can be used to calculate a wind pressure using the Bernoulli Equation relating velocities to pressures. Since wind is air in motion the resulting wind pressures are related to its kinetic energy and can be determined by the following expression:

$$P = (\gamma)\left(\frac{V^2}{(2)(g)}\right)$$ where,

P is wind pressure in lb/ft^2 or N/m^2 (pascal)
γ is specific weight of air in lb/ft^3 or kg/m^3
g is gravitation force in ft/sec^2 or m/sec^2 and
V is the average wind speed in ft/sec or m/sec

P is more commonly seen in the following form:

$$P = \tfrac{1}{2}\,\rho\, V^2$$ where,

P is wind pressure in lb/ft^2 or N/m^2 (pascal)
ρ is an average air density - 0.0809 lb/ft^3 or 1.29 kg/m^3 and
V is the average wind speed in ft/sec or m/sec

Further simplifying gives:

$$P = (x)(V^2)$$ where,

x is the unit conversion, based on which velocity units the designer is using, see Table 1.1

This is called the **"stagnation pressure"** or total pressure because it refers to the maximum positive increase over ambient pressure that can be exerted on the fence by any given wind speed. Stagnation pressure is the basic, non-factored pressure to which all other pressures are referred to and are usually referenced in regional building codes.

TABLE 1.1

Unit Conversions		
V	**x**	**Yields**
ft/sec	0.00119	PSF
m/sec	0.00064645	kPa
mph	0.00256	PSF
km/hr	0.00004807	kPa

Table 1.2 provides a few stagnation pressures computed from the given wind speeds. If the 50-year return period velocity is equal to the wind speed in Table 1.2, the tabulated values for wind pressure can be used in your design.

TABLE 1.2

Wind Speed Verses Wind Pressure								
Wind Speed (V)	mph	60	70	80	90	100	110	120
	km/hr	96	113	129	145	161	177	193
Wind Pressure (q)	psf	9.3	12.6	16.4	20.8	25.6	31.0	36.9
	kPa	0.443	0.603	0.785	0.995	1.23	1.48	1.77

Exposure Effects

Wind pressures exerted on the AB Fence depend not only on the speed of the wind, but on the interaction of exposure effects as well. Any structure, including but not limited to, buildings, landscape features, general topography, and open areas such as fields, parks, parking lots, street corridors, and bodies of water all significantly affect the wind patterns and need to be considered. An exposure category that adequately reflects the characteristics of ground surface irregularities is determined for the site. Open terrain allows for the maximum exposure, while fences found in developed or urban areas have minimum exposure. Described below are the three exposure categories used in the designs of the AB Fence:

- **Exposure B**: Surface roughness consisting of urban and suburban areas, wooded areas, or other terrain with numerous closely spaced obstructions having the size of a single family dwelling or larger.

- **Exposure C:** Surface roughness consisting of open terrain with scattered obstructions having heights generally less than 30 ft (9.1 m) extending ½-mile (0.8 km) or more from the site. This category includes flat open country, grasslands, and bodies of water under 1-mile (1.6 km) in width.

- **Exposure D:** Describes the most severe exposure with surface roughness consisting of flat, unobstructed areas and bodies of water over 1-mile (1.6 km) in width. Exposure D extends inland from the shoreline ¼-mile (0.4 km).

Additionally, calculations should also include site topography and structural importance when factoring wind pressures on a structure. These AB Pressure Coefficients are listed in Table 1.3 by the exposure category, but also account for general site topography, structure height and structural importance as well.

Again, for AB Fence designs the wind pressure is based on the 50-year average wind speed. The pressure should be multiplied by the appropriate Pressure Coefficient to determine a factored pressure. This factored pressure is then used in the design calculations.

Codes have changed over the years and you need to understand what the differences are to ensure the correct wind speed associated with the codes are being used in the design. For example, without providing to much detail, the design wind speeds are different because the basis for wind design was service-level, fastest mile wind speeds in ASCE 7-93, service-level, 3-second gust wind speeds in ASCE 7-05 and strength-level, 3-second gust wind speeds in ASCE 7-10.

Table 1.3

Pressure Coefficient		
Exposure	**H<12ft (3.7m) Pressure Coefficient**	**H>12ft (3.7m) Pressure Coefficient**
B	0.68	0.85
C	0.9	1.2
D	1.25	1.5

Design Wind Pressure (*DWP*) is defined as the wind pressure the designing engineer has determined based on their local code or municipality requirements. *DWP* will be used in the design example that follows.

System Configuration

Allan Block Fence is designed to resist laterally applied pressures, specifically the pressure applied by wind. The system resists pressures by distributing the applied forces to the systems structural elements. The elements of the system are made up of the posts, bond beams, dry-stacked panel block and concrete pile footings (Figure 2). The height and width of a single panel makes up the **tributary area** of which each element must be designed.

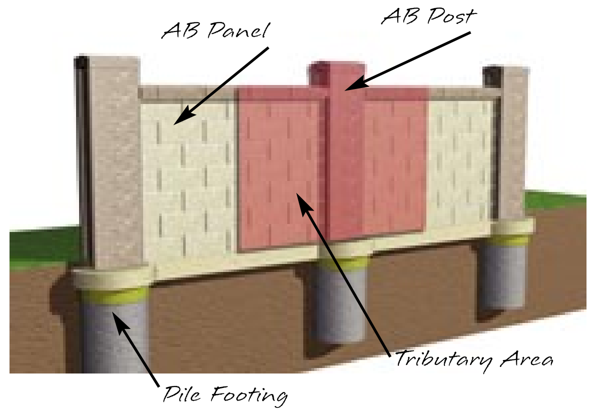


Figure 2: Tributary Area Per Post

The **panel** (Figure 3) is made up of dry-stacked panel block and **bond beams**. Bond Beams are dry-stacked panel block combined with horizontal and vertical steel which are cast solid with a fine sand-mix concrete grout meeting design strength requirements (Figure 4). Typically there is a bond beam at the top and the bottom of each panel. Intermediate bond beams are added as needed, depending upon the design height and length of the panel.

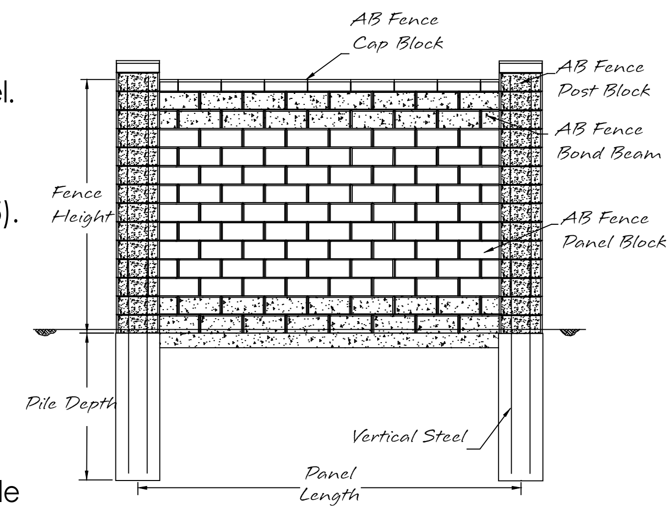


Figure 3: Typical Panel Elevation

The fully constructed panel acts to transfer the applied pressure to the main structural element, the **post** (Figure 5). The post is made up of individually stacked post block combined with vertical steel and cast solid with a standard concrete mix meeting design strength requirements. The vertical steel reinforcement is lap spliced with footing dowels to transfer the applied overturning forces into the footing structure. The **footing** structure can be a variety of different types ranging from a simple shallow pile footing, to a very complex designed deep caisson.

A site specific evaluation along with the magnitude of the structure will allow the engineer to choose the appropriate footing type. This document includes a simple pile footing, which will cover the majority of AB Fence projects.

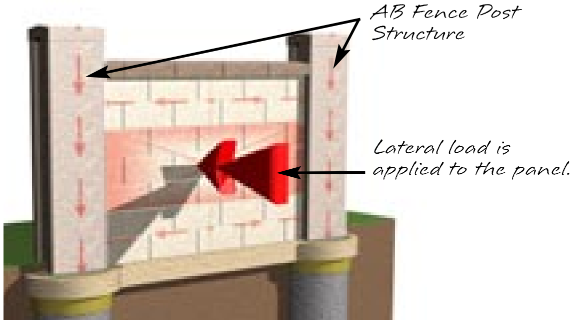


Figure 5: Fence Post Structure

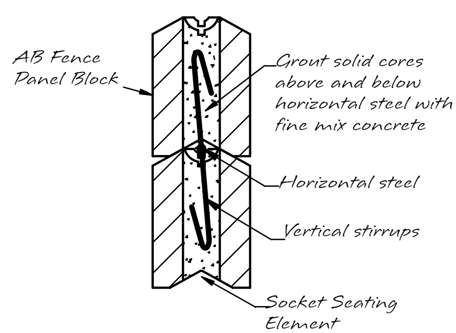


Figure 4: Typical Bond Beam

Panel Configuration

The panel's dry-stacked units and bond beams work in unison to both resist the applied wind pressure and distribute these forces to the structural posts. Figure 6 shows a typical AB Fence Panel cross section. Each panel block has a unique ball and socket configuration which when stacked in a running bond pattern, interlock together to form a semi-rigid panel. The interlocking strength is due to the selfweight of the block above pushing down on each course. The lowest courses within a panel have the most interlocking strength due to the greater selfweight from above. Figure 7 illustrates the flexing of a panel under extreme loading and how selfweight helps to resist bulging. In order for bulging to occur in the panel, the locking forces within the ball and socket joint of the dry-stacked units must literally lift the courses of block above the bulge. The selfweight of these courses enhances the strength and rigidity of the panel and continues to increase as you move lower in the panel.

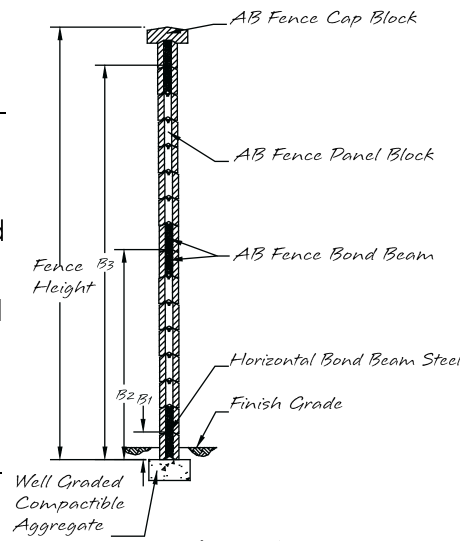
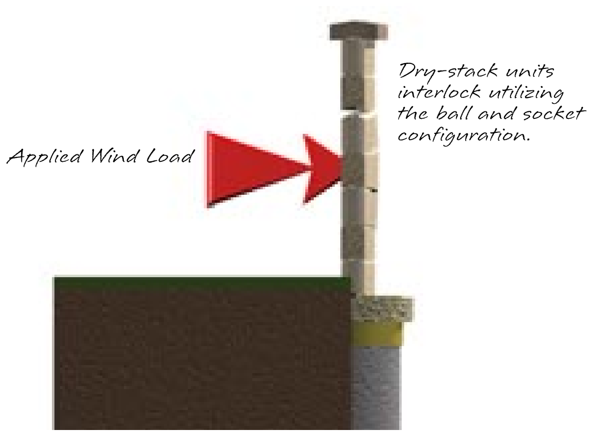


Figure 6: Typical Panel Section

The bond beams are made using two courses of individual panel block with a single #4 (10M) reinforcing bar cast between the courses. The cores are cast solid with a fine sand-mix concrete grout and vertical stirrups are placed in every other block core to add shear strength to the bond beam (see Figure 4). The composite nature of the bond beam and the dry-stacked unit's ball and socket is what allows the panel to perform at such a high level.

As the panel is stressed by the applied wind loads the bond beam and dry-stacked block are subject to minor deflections. These minor deflections engage the bond beam's steel and the interlock of the ball and socket. Which causes an increase in ultimate panel capacity. Individual bond beam test results have consistently shown that it acts exactly like a monolithic reinforced beam and has much higher actual moment capacities than are used in a simple design calculation.

By combining the natural strength of the composite bond beam with the strength the ball and socket configuration brings to the system, a designer can show an increase in the capacity of the individual bond beams during calculations. Allan Block suggests the addition of a conservative 1.5 multiplier to the calculated bond beam capacity to account for the rigidity of the ball and socket. See Chapter Two for this concept shown in calculation.



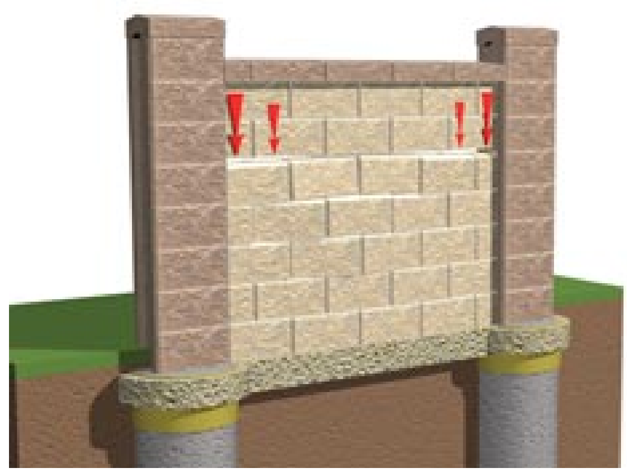


Figure 7 Dry Stacked Interlock

System Selfweight

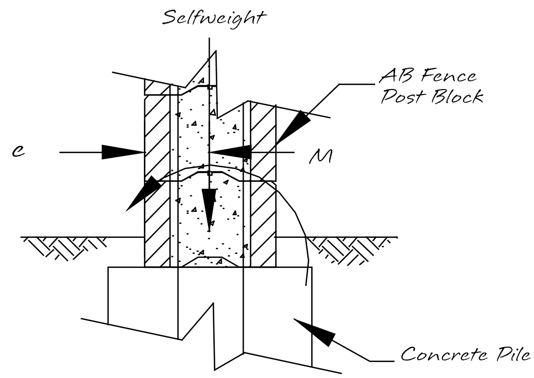


Figure 8:
Selfweight Resisting Movement

The AB Fence System has many advantages since it is a concrete masonry system. It provides superior durability and low maintenance, but also provides weight similar to a gravity retaining wall. The weight of the system when combined with its eccentricity (*e*) creates a moment (*M*) that needs to be overcome before any applied force can actually engage the flexural steel (Figure 8). Concrete masonry products have a significant selfweight of roughly 135 pcf (2162.5 kg/m^3). The design engineer can utilize the inherent resistance of the selfweight to reduce the applied moments at the base of the post. The design engineer can choose to ignore the value of the systems selfweight but by doing so they are treating this concrete system the same as a light weight wooden fence. This manual will utilize 90% of the calculated selfweight resistance in all design examples.

Flexibility and Strength

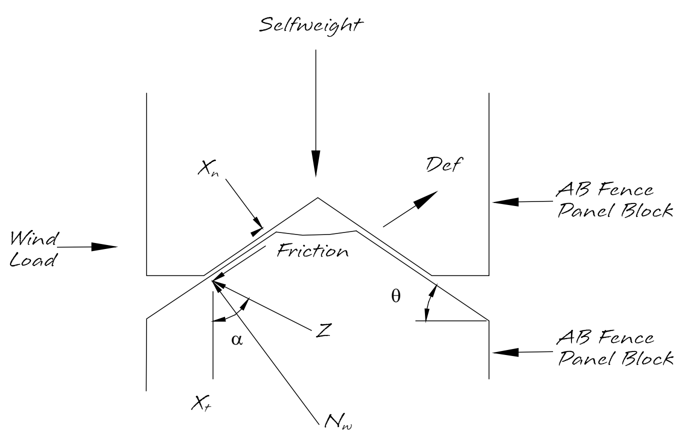


Figure 9:
Work Energy Free-Body Diagram

The benefit of the dry-stacked units does not end with simply added flexural strength. The more intriguing capability of the dry-stacked units within the assembled panel is their ability to dissipate and distribute applied forces. This ability was first observed in the full-scale panel testing Allan Block and the University of Calgary completed in 2003, where the applied force did not equal the forces received at the post structures. In fact, they were considerably less. Further investigation and testing showed that the simple static engineering law of "force in equals force out" did not hold true to the AB Fence Panel using dry-stacked units, which have a large selfweight and a ball and socket configuration. The AB Fence Panel configuration brings a dynamic variable to the static equation. This dynamic variable can best be described as Work Energy.

Work Energy is defined as a force (*wind*) acting upon an object (the panel block's ball and socket joint) causing a displacement (Figure 9). In the Allan Block Fence panel there are two forms of work energy being developed, external work and internal work. First is the external work, which is simply the deflection of the entire panel due to the wind force. However, because the Panel is free to move within the Post notch, there is no friction to overcome.

The second form of Work Energy occurs internally in the ball and socket joint. As the wind load is applied, the running bond of the dry stacked block try to deflect away from the force laterally, but the socket resists any deflection due to its natural conical locking configuration. The selfweight of all the courses above a particular socket joint provides the downward force. This selfweight force serves to stiffen the joint. Thus, the lower the joint is within the panel the greater the internal resisting forces within that joint or socket. Therefore, most of the deflection within the panel occurs toward the top of the panel where the selfweight is less.

The internal work occurs when the applied force becomes great enough to overcome the frictional interaction within the socket which results in a deflection. There are two forms of deflection that could occur. The first is a purely horizontal translation, but this could only occur if the bottom tension edge of the panel block were to shear off horizontally allowing the socket to release (Figure 10).

This form of deflection never occurred in any of the full-scale tests performed due to the internal strength of each block, 3000 psi (20.7 MPa) min. The shear strength of a block is directly related to its compression strength, therefore the stronger the block the more resistant to shear failures and the stronger the ball and socket can become.

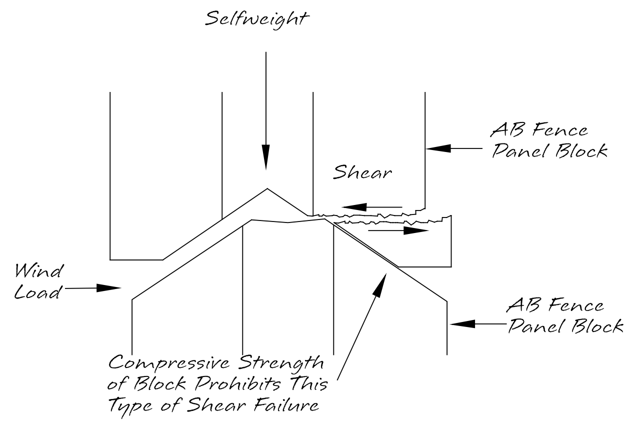


Figure 10:
Possible Shear Failure Diagram

The second form of deflection, which did occur during testing, was a movement along the natural sloped plane of the socket which provided displacement in an upward and lateral direction (variable X_t in Figure 9). Each movement when it occurred was very small because the pressure within the socket would release and the frictional interaction would once again be greater than the applied load. Once the force was built up enough to overcome the internal resisting forces another deflection would occur. Each time an internal deflection occurred a certain amount of force was absorbed into the joint causing a reduction of applied forces to the posts.

The results showed that at low pressures the loads received at each post are quite small. The lowest recorded test value was 28% of the applied load. This is due to the large number of dry-stacked joints within the panel that had the ability to shift or deflect early on. At higher pressures the number of joints having the ability to adjust decreases because movement has already occurred making the joint more rigid, which causes the percentage of force received by each post to increase. The result of the Work Energy effect is an absorption of the applied loads. When this occurs the applied moments to the post structures are also reduced. This allows the designer to increase the tributary area by increasing the post spacing. The net result is a smaller number of posts and footings required, and a reduced cost for a project. In calculation, this Work Energy effect is represented as an increase to the posts calculated capacity.

Table 1.4 represents the recommended post capacity increase to reflect the Work Energy findings based on the test results. These post capacity increases will be used in the design example in Chapter Two.

Table 1.4

Design Wind Speeds and Stagnation Pressures								
Miles Per Hour (kph)	mph	60	70	80	90	100	110	120
	km/hr	96	113	129	145	161	177	193
Unfactored Pressure lb/ft^2 (kPa)	psf	9.3	12.6	16.4	20.8	25.6	31.0	36.9
	kpa	0.443	0.603	0.785	0.995	1.23	1.48	1.77
Design Capacity For Post Design Multiplier								
	% *	1.50	1.50	1.45	1.35	1.30	1.20	1.10
*** The multipliers are a conservative increase based on test results**								

Post Configuration

Figure 11: Post Core After Testing and Demolition

The AB Fence Post is a fully tested structural column assembly that has repeatedly shown ultimate capacities similar to those of a monolithic reinforced concrete post. The post block has a unique conical shaped core that when stacked with additional courses forms a serrated shaped interior core of concrete. Figure 11 shows the core of the AB Fence Post after flexural testing and demolition to remove the AB Fence Post masonry material. To remove the masonry material, an electric jack hammer was required. This unique shaped interior adds to the incredible bonding effect the dry-cast block have with the wet-cast concrete core which enhances the monolithic nature of the post system. The testing results have proven that the full masonry composite section should be used in design applications. Therefore, first principle beam capacity equations utilizing the full composite section of the post will be used throughout this manual along with the suggested capacity increase multipliers from Table 1.4

Footing Configuration

The stabilizing foundation to the entire AB Fence System is a reinforced concrete footing. Footings can be designed in many different styles but they all are designed to resist the lateral and vertical applied forces. The typical AB Fence footing is a 2 ft (600mm) diameter concrete pile footing directly under the post drilled to a design depth with simple vertical steel reinforcement. The site specific parameters such as soil strength and wind loading will determine the design size and depth of each shaft. The vertical pile footing reinforcement should be designed to match the vertical steel within the post structure and be extended out of the top of the footing to splice with the post reinforcement. By increasing the pile footings diameter and or depth, the capacity of the footing can be increased.

This manual will follow standard calculations for non-constrained concrete pile footings. However, design engineers can choose to design their own type or style of footing by determining the overturning moments at the base of the AB Fence Post. The Allan Block Fence system will work with any type of foundation system which will adequately handle the overturning moments such as a complex Drilled Shaft, spread footing or cantilever footing.

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CHAPTER TWO
AB Fence Engineering Methodology

This chapter will provide an explanation of engineering principals, terminology and methodologies used in the design of the AB Fence system.

Terminology

Ab	= Area of steel for one reinforcing bar in the Post
A_{bb}	= Area of steel reinforcing bar in the Bond Beam
As	= Total Area of steel in the Post
Aw	= The thickness of the Post Block wing
$Awpanel$	= Area of Panel section only
b	= Diameter of Footing
b_{bb}	= Bond Beam section length used for Bond Beam capacity calculations = (2)(h)
bs	= Post section length used for Post capacity calculations = Pl - (2)(Pnd)
clr	= Spacing between nub and bottom of Post Block notch
d	= Calculated depth of footing
d_z	= Estimated depth of footing
d_{bb}	= Distance to tension steel in the Bond Beam
ds	= Distance to tension steel in the Post
DWP	= Design Wind Pressure
Em	= Modulus of Elasticity of masonry
Es	= Modulus of Elasticity of nonprestressing steel
Fa	= Active Earth Pressure
Fah	= Horizontal Force Vector of Active Earth Pressure
Fq	= Surcharge Force
Fqh	= Horizontal Force Vector of Surcharge Force
fb	= Allowable Compressive Strength of masonry
fm	= Compressive Strength of concrete
fs	= Allowable Tensile Stress of reinforcing steel = (0.4)(fy)
fy	= Yield Stress of reinforcing steel
h	= Course Height
h_1	= Distance in feet from ground surface to point of applied load
H	= Total Panel height from footing to top of cap
Hs	= Retained height of soil
j	= j and k are coefficients used for internal moment and definitions of the neutral axis of the Post
j_{bb}	= j_{bb} and k_{bb} are coefficients used for internal moment and definitions of the neutral axis of the Bond Beam
k	= j and k are coefficients used for internal moment and definitions of the neutral axis of the Post
k_{bb}	= j_{bb} and k_{bb} are coefficients used for internal moment and definitions of the neutral axis of the Bond Beam
K_a	= Lateral Earth Pressure Coefficient

Terminology

M_{postd}	= Applied Moment to Post = $(P)(Ta)(H / 2)$
M_{paneld}	= Applied Moment to Bond Beam = $(P)(Ta)\{PS / [(8)(N_{bb})]\}$
Mc_{bb}	= Allowable Moment Capacity of Bond Beam based on the masonry compressive strength
Mcp	= Allowable Moment Capacity of Post based on the masonry compressive strength
$M_{footing\ design}$	= Total Moment used to design Footing = $M1$ - selfweight moment for the Post. Panel and Footing
Mt_{bb}	= Allowable Moment Capacity of Bond Beam based on the Tensile Stress of the reinforcement
Mtp	= Allowable Moment Capacity of Post based on the Tensile Stress of the reinforcement
$M_{swfooting}$	= Total resistance Moment due to the selfweight of the Footing
$M_{swpanel}$	= Total resistance Moment due to the selfweight of the Panel
M_{swpost}	= Total resistance Moment due to the selfweight of the Post
$M_{post\ design}$	= Total Moment used to design Post = $M_{postd} - M_{swpanel} - M_{swpost}$
Mah	= Overturning Moment due to Soil Retention
Mqh	= Overturning Moment due to Surcharge force
n	= Modular Ratio and is calculated using the Modulus of Elasticity of the composite materials
N_{bb}	= Number of Bond Beams in a Panel
nl	= Nub Length
P	= Bernoulli's Wind Pressure
$P1$	= The footing's design moment translated into its Force Vector
Pd	= Post Block Depth
Per	= Work Energy Factor
PH	= Total Post Height from footing to top of cap
Pl	= Post Block Length
Pnd	= Post Block Notch Depth
Ps	= Post Spacing from Center to Center of Posts
q	= Surcharge Force in Soil retention calculations
ρ_{post}	= Steel to Concrete ratio in the Post
ρ_{bb}	= Steel to Concrete ratio in the Bond Beam
r	= radius of the reinforcing bars in a structural member
s	= Number of Panel Block long panel used for post spacing
$S_{factored}$	= Allowable lateral soil-bearing pressure based on a depth of 1/3 the depth of embedment
S_{ssa}	= Allowable Shear Stress for reinforced structures
S_{req}	= Calculated Shear Stress at the base of the Post
S_{wing}	= Allowable Shear Stress on the Post wing
S_{wreq}	= Total Shear Stress on the Post wing
t	= Panel Block Depth
Ta	= $(Ps)(H)$ = Tributary Area of panel from center to center of Posts
w	= Panel Block Length
wc	= Unit Weight of Concrete = 135 pcf (2162.5 kg/m^3)
wt_{cap}	= Weight of Cap unit
wt_{panel}	= Weight of Panel Block
wt_{panelg}	= Weight of grout per Panel Block
wt_{post}	= Weight of Post Block
wt_{postc}	= Weight of grout per Post Block
Z_{panel}	= Number of block course in a Panel
Z_{post}	= Number of block course in a Post
ϕ_i	= Internal Friction Angle of soil
ϕ_{wi}	= Weighted Internal Friction Angle of soil
β	= Wall Batter
γ_i	= Unit Weight of Soil

Design Example

To start a design there is typically a total length and desired height of fence shown on the site plan documents. The length can be divided into equal segments to get a rough starting post spacing. The post spacing of an AB Fence should be based on the modular lengths of the individual panel block to minimize cutting and speed construction. The designer should maximize post spacing to minimize project costs. For detailed instructions on installation see the AB Fence Installation Guide.

Allan Block Fence Parameters:

Course height (h)	= 7.625 in (194 mm)
Panel Block depth (t)	= 5.628 in (143 mm)
Panel Block length (w)	= 17.625 in (448 mm)
Post Block depth (Pd)	= 11.625 in (295 mm)
Post Block length (Pl)	= 17.625 in (448 mm)
Post Block Notch depth (Pnd)	= 1.5 in (38 mm)
Nub length (nl)	= 0.1875 in (5 mm)
Clear space between nub and bottom of post notch (clr)	= 0.25 in (6 mm)

Example:

Fence Parameters: Allan Block recommends that all AB Fence projects be built with castellated fence posts. These are posts that are at least one block taller than the panel to allow for panel movement.

Fence length	= 175 ft (53.34 m)
Average height	= 7.5 ft (2.29 m)
Design Wind Pressure (DWP)	= 11.15 psf (0.534 kPa)
# of Bond Beams (N_{bb})	= 2 (1 - #4 (10M) each)
Size and # of bars in Post	= 4 - #5 (15M)
Work Energy Factor (Per)	= 1.5 - (Table 1.4)

NOTE: No soil retention required in this example, for soil retention calculations see pages 21-22.

For this example we will equally divide the total length of Fence into equal sized panels. The designer may want to simply calculate the maximum panel spacing.

Rough post spacing = 174 ft / 12 panels = 14.5 ft ∪ 9 panel block

Therefore: Each post spacing is made up of (s) number of Panel Blocks = 9

$Ps = (s)(w) + (2)(nl + clr) - (2)(Pnd) + (2)(Pl / 2)$

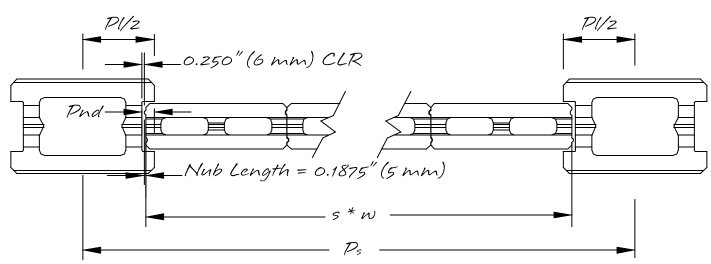
Ps = 14.51 ft (4.42 m)

Height of Panel (H):

Z_{panel} = 12 course

$H = (Z_{panel} - 1)(h) + 7.16 \text{ in} + 4.75 \text{ in}$

= 7.98 ft (2.43 m)



Design Example

Height of Post (H):

Z_{post} = 13 course (Castellated = 1 more than panel)

PH = $(Z_{post})(h)$ + 4.75 in = 8.66 ft (2.64 m)

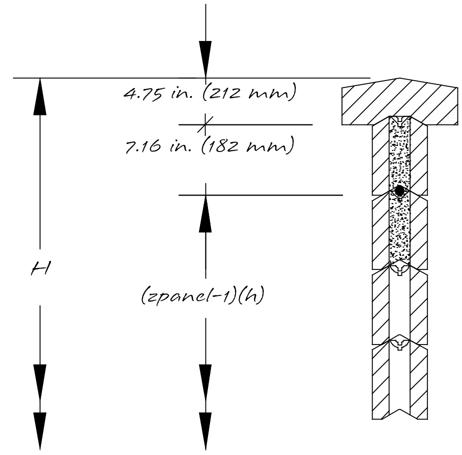
Tributary Area (Ta):

Ta = $(Ps)(H)$

= (14.51 ft)(8.66 ft) = 115.825 ft^2 (10.76 m^2)

Designed Wind Pressure(DWP):

DWP = 11.15 psf (0.534 kPa)



Applied Design Moments: The following moment equations are from standard engineering principles.

Post: Cantilever Beam - Uniformly Distributed Load

M_{postd} = $(DWP)(Ta)(H / 2)$

= (11.15 psf)(115.825 ft^2)(7.98 ft / 2)

= 5154.1 lb-ft (6988 N-m)

NOTE: This Post Moment will be reduced by using the influence of selfweight in the next section.

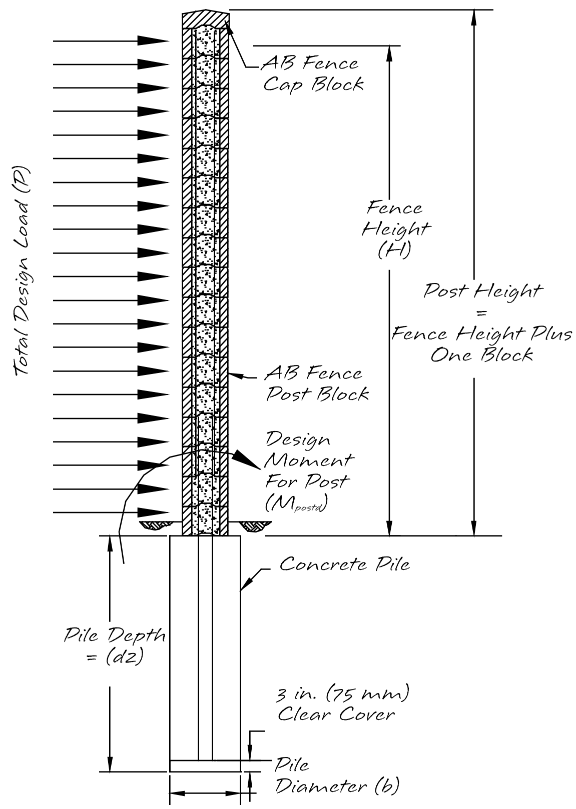
$$M_{paneld} = \frac{(DWP)(Ta)(Ps)}{(8)(N_{bb})}$$

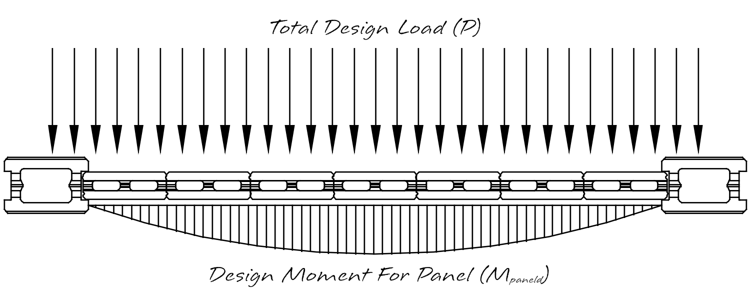
Panel: Simple Beam - Uniformly Distributed Lateral Load

$$= \frac{(11.15\text{ psf})(115.825\text{ ft}^2)(14.51\text{ ft})}{(8)(2)}$$

= 1171.25 lb-ft (1588 N-m)

NOTE: The AB Fence Bond Beam and Post capacities must be greater than this applied value.





Note: The bottom bond beam is not designed as simply supported vertically between concrete piles. The entire panel is supported uniformly on the compacted granular base. Therefore the design moment for all bond beams is in the lateral bending direction. To be conservative, any frictional resistance between the bottom bond beam and the gravel base is ignored, thus all lateral forces are distributed evenly between all bond beams. If the engineer wants to design the bottom bond beam as simply supported between pile caps, both the bottom bond beam and the concrete pile caps must be evaluated and designed accordingly.

Design Example

Determine the resisting moments due to Selfweight of Post, Panel and Footing:

Weight of Panel Block (wt_{panel}) = 47 lb (209.07 N)
Weight of Post Block (wt_{post}) = 70 lb (311.38 N)
Weight of Cap unit (wt_{cap}) = 60 lb (266.89 N)
Weight of grout per Panel Block (wt_{panelg}) = 14.4 lb (64.05 N)
Weight of concrete per Post Block (wt_{postc}) = 48 lb (213.51 N)

Total weight of Post = $(Z^{post})(wt_{post} + wt_{postc}) + wt_{cap}$
= (13) (70 lb + 48 lb) + 60 lb
= 1594 lb (7090.4 N)

Total weight of Panel = $(Z_{panel})(s)(wt_{panel}) + (wt_{cap})(s)$
= (12)(9)(47 lb) + (60 lb)(9)
= 5616 lb (24981.2 N)

Weight of Bond Beam (bb) grout:

\# of grouted course = (N_{bb})(2 course per Bond Beam)
= (2)(2) = 4

wt of bb grout = (4)(s)(wt_{panelg})
= (4)(9)(14.4 lb)
= 518.4 lb (2306.0 N)

Total weight of Panel = 5616 lb + 518.4 lb = 6134.4 lb (27293.6 N)

Estimate Footing weight:

Diameter (b) = 2 ft (0.610 m)
Estimated depth (d_2) = 4.5 ft (1.37 m)
Weight of concrete (wc) = 135 pcf (2162.5 kg/m^3)

Est. Wt of Footing = $(\pi)(b / 2)^2 (d2)(wc)$
= (π)(2 ft / 2)^2(4.5 ft)(135 pcf)
= 1908 lb (8487.2 N)

Design Example

Determine the total resistance moments due to the weight of the post, panel and footing:

Post: M_{swpost} = (wt of post)(Pd / 2)

$$= (1594 \text{ lb}) \left(\frac{11.625 \text{ in}/12 \text{ (in/ft)}}{2}\right)$$

= 772.1 lb-ft (1046.83 N-m)

NOTE: The moment arm for the post Is the width of the post (Pd) divided by 2.

Panel: $M_{swpanel}$ = (wt of panel)(t / 2)

$$= (6134.4 \text{ lb}) \left(\frac{5.628 \text{ in}/12\text{(in/ft)}}{2}\right)$$

= 1438.5 lb-ft (1950.34 N-m)

NOTE: The moment arm for the panel is the width of the panel (t) divided by 2.

Footing: $M_{swfooting}$ = (wt of footing)(Pd / 2)

$$= (1908 \text{ lb }) \left(\frac{[11.625 \text{ in}/12 \text{ (in/ft)}]}{2}\right)$$

= 924.2 lb-ft (1253.05 N-m)

NOTE: The equivalent moment arm for the footing can be estimated similar to that of the post, therefore (Pd) divide by 2.

Design Moment for Post design

$M_{postdesign}$ = M_{postd} - (0.9)(M_{swpost} - $M_{swpanel}$)

= 5154.1 lb-ft - (0.9)(772.1 lb-ft + 1438.85 lb-ft)

= 3164.2 lb-ft (4290.1 N-m)

NOTE: The AB Fence post capacity must be greater than this value.

Design Moment for Footing design

$M_{footingdesign}$ = M_{postd} - (0.9)(M_{swpost} - $M_{swpanel}$ - $M_{swfooting}$)

= 5154.1 lb-ft - (0.9)(772.1 lb-ft + 1438.85 lb-ft + 924.2 lb-ft)

= 2332.5 lb-ft (3162.5 N-m)

NOTE: This value will be used for determining design depth of the post footing.

Design Example

Compressive Strength Calculations

Allowable moment capacity based on compressive strength of masonry for the post (Mcp):

$$Mcp = \frac{(fb)(bs)(ds^2)(j)(k)}{2}$$

Compressive strength:

fm = 3000 psi (20.68 MPa)

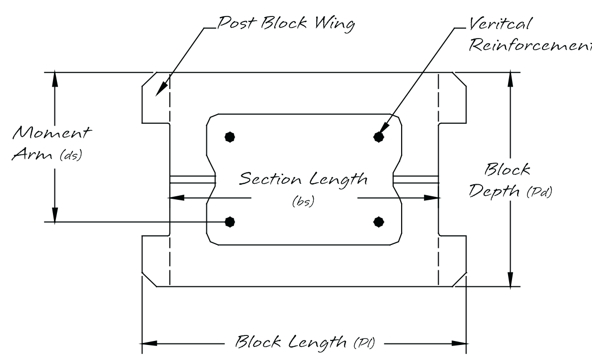
NOTE: This is the minimum allowable compressive stress of the block units based on ASTM 1372. If the tested values show a greater strength the designer may choose to use the higher tested value.

The allowable compressive strength for masonry design:

fb = (0.333)(fm)
= 1000 psi (6.89 MPa)

Post section dimensions are based on the rectangular section of the block depth and block length which does not include the wings.

Post section length (bs):



bs = Pl - (2)(Pnd)
= 17.625 in - (2)(1.5 in)
= 14.625 in (371.5 mm)

Distance to tension steel (ds):

ds = Pd - 2.25 in - 1 in c/r - bar dia.
= 8.06 in (204.7 mm)

j and k are coefficients used for internal moments and definitions of the neutral axis.

$$k = \{[(n)(\rho_{post})]^2 + (2)(n)(\rho_{post})\}^{0.5} - (n)(\rho_{post})$$

$$j = 1 - \frac{k}{3}$$

Ratio of reinforcing steel in post section:

$$\rho_{post} = \frac{(As / 2)}{(bs)(ds)}$$

NOTE: As / 2 because only the tension steel is used.

Design Example

Compressive Strength Calculations

Area of steel in post section (As):

Area of bar (Ab) $= (\pi)(r^2)$

$= 0.307$ in^2 (198.1 mm^2)

$As = (Ab)$(# of bars in post)

$= (0.307)(4) = 1.227$ in^2 (791.61 mm^2)

Therefore: $\rho_{post} = \dfrac{As / 2}{(bs)(ds)}$

$= \dfrac{1.227 \text{ in}^2 / 2}{(14.625 \text{ in})(8.06 \text{ in})}$

$= 0.0052$

n is the modular ratio and is calculated using the modulus of elasticity of the composite materials:

$n = Es / Em$

Es is the modulus of elasticity of for nonprestressed steel:

$Es = 29000$ ksi (200,000 MPa)

Em is the modulus of elasticity of masonry, commonly taken as:

$Em = (900)(fm)$

$= (900)(3000$ psi$)$

$= 2700$ ksi (18,615.8 MPa)

Therefore: $n = 29000$ ksi/ 27000 ksi

$= 10.741$

Therefore: $k = \{[(n)(\rho_{post})]^2 + (2)(n)(\rho_{post})\}^{0.5} - (n)(\rho_{post})$

$= \{[(10.741)(0.0052)]^2 + (2)(10.741)(0.0052)\}^{0.5} - (10.741)(0.0052)$

$= 0.2830$

and: $j = 1 - \dfrac{k}{3}$

$= 1 - \dfrac{0.2830}{3}$

$= 0.9057$

$Mcp = \dfrac{(fb)(bs)(ds^2)(j)(k)}{2}$

$= \dfrac{(1000 \text{ psi})(14.625 \text{ in}/12 \text{ in/ft})(8.06^2 \text{ in}^2)(0.9057)(0.283)}{2}$

$= 10157$ lb-ft (13,771 N-m)

At this point the Work Energy factor is put into the equations, from Table 1.4.

$Mcp = (Per)(10157$ lb-ft$)$

$= (1.45)(10157$ lb-ft$)$

$= 14728$ lb-ft (19,968.5 N-m)

This is the allowable moment capacity for this post section and can than be compared to the design applied moment ($M_{post\ design}$) of 3164.2 lb-ft (4290.1 N-m). The moment capacity is much greater than the applied moment therefore this section is safe to use.

Design Example

Compressive Strength Calculations

Allowable Moment capacity based on compressive strength of masonry for the bond beam (Mc_{bb}):

$$Mc_{bb} = \frac{(fb)(b_{bb})(d_{bb}^2)(j_{bb})(k_{bb})}{2}$$

Bond beam section length (b_{bb}):

b_{bb} = (2)(h) = (2)(7.625 in) = 15.25 in (387.35 mm)

Distance to tension steel (d_{bb}):

d_{bb} = t / 2 = 5.628 in / 2 = 2.814 in (71.48 mm)

j and k are coefficients used for internal moments and definitions of the neutral axis.

$$k_{bb} = \{[(n)(\rho_{bb})]^2 + (2)(n)(\rho_{bb})\}^{0.5} - (n)(\rho_{bb})$$

$$j_{bb} = 1 - \frac{k_{bb}}{3}$$

Ratio of reinforcing steel in bond beam section:

$$\rho_{bb} = \frac{A_{bb}}{(b_{bb})(d_{bb})}$$

Area of steel in bond beam section (A_{bb}):

Area of bar (Ab) = (π)(r^2) = 0.196 in^2 (126.45 mm^2)

A_{bb} = (Ab)(# of bars in bond beam) = (0.196)(1) = 0.196 in^2 (126.45 mm^2)

Therefore: $\rho_{bb} = \frac{A_{bb}}{(b_{bb})(d_{bb})}$

= 0.196 in^2 / [(15.25 in)(2.814 in)] = 0.0046

Therefore: $k_{bb} = \{[(n)(\rho_{bb})]^2 + (2)(n)(\rho_{bb})\}^{0.5} - (n)(\rho_{bb})$

$= \{[(10.741)(0.0046)]^2 + (2)(10.741)(0.0046)\}^{0.5} - (10.741)(0.0046) = 0.2682$

and: $j_{bb} = 1 - \frac{k_{bb}}{3}$

$= 1 - \frac{0.2682}{3}$

= 0.9106

$$Mc_{bb} = \frac{(fb)(b_{bb})(d_{bb}^2)(j_{bb})(k_{bb})}{2}$$

$$= \frac{(1000\text{ psi})(15.25\text{ in}/12\text{ in/ft})(2.814^2\text{ in}^2)(0.9106)(0.2682)}{2}$$

= 1228.8 lb-ft (1666.0 N-m)

Note: Bond Beam test results have consistently shown much higher moment capacities. This is due to the ball and socket configuration of the panel block and the flange effect of the glued in place cap block. Thus the 1.5 multiplier on $Mcbb$.

Mc_{bb} = (1.5)(1228.8 lb-ft)

= 1843.1 lb-ft (2498.9 N-m)

This is the allowable moment capacity for this bond beam section and can than be compared to the design applied moment (M_{paneld}) of 1171.25 lb-ft (1588.0 N-m). The moment capacity is much greater than the applied moment therefore this section is safe to use.

Design Example

Tensile Stress Calculations

Allowable moment capacity based on tensile stress of reinforcement in the Post (Mtp):

$$Mtp = (fs)(As / 2)(j)(ds)$$

Yield stress (fy) in reinforcing steel is commonly known as 60 ksi (413.68 MPa) but the allowable tensile stress is 40% of the yield. Therefore:

$$fy = 60 \text{ ksi} \quad (413.68 \text{ MPa})$$
$$fs = (0.4)(fy) = (0.4)(60) = 24 \text{ ksi} \quad (165.47 \text{ MPa})$$

Therefore:

$$Mtp = (fs)(As / 2)(j)(ds)$$
$$= (24000 \text{ psi})(1.227 \text{ in}^2 / 2)(0.9057)(8.06)$$
$$= 8961.3 \text{ lb-ft} \quad (12{,}149.89 \text{ N-m})$$

At this point the Work Energy Factor (per) is put into the equations, from Table 1.4, on Page 7.

$$Mtp = (Per)(8961.3 \text{ lb-ft})$$
$$= (1.5)(8961.3 \text{ lb-ft})$$
$$= 13442 \text{ lb-ft} \quad (18{,}224.84 \text{ N-m})$$

This is the allowable moment capacity for this post section and can than be compared to the design applied moment ($M_{post\ design}$) of 3164.2 lb-ft (4290.1 N-m). The moment capacity is much greater than the applied moment therefore this section is safe to use.

Allowable Moment Capacity based on Tensile Stress of reinforcement in the Bond Beam:

$$Mt_{bb} = (fs)(A_{bb})(j_{bb})(d_{bb})$$
$$= (24000 \text{ psi})(0.196 \text{ in}^2)(0.9106)(2.814)$$
$$= 1006.3 \text{ lb-ft} \quad (1364.36 \text{ N-m})$$

Note: Bond Beam test results have consistently shown much higher moment capacities. This is due to the ball and socket configuration of the panel block and the flange effect of the glued in place cap block. Thus the 1.5 multiplier on Mt_{bb}.

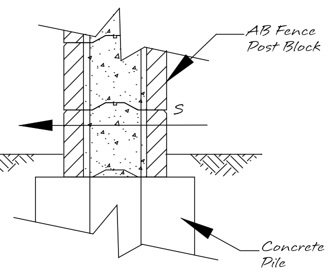
$$Mt_{bb} = (1.5)(1006.3 \text{ lb-ft})$$
$$= 1509.4 \text{ lb-ft} \quad (2046.47 \text{ N-m})$$

This is the allowable moment capacity for this bond beam section and can than be compared to the design applied moment (M_{paneld}) of 1171.25 lb-ft (1588.0 N-m). The moment capacity is much greater than the applied moment therefore this section is safe to use.

Design Example

Concrete Shear Calculations

All structural calculations contain a required section on shear but with the AB Fence system shear is not the limiting factor in design and you will see that the capacities far exceed the design requirements. Shear is simply the action of breaking the structural member lateral to its flexural steel. In the AB Fence calculations a designer should check the shear capacity of the post where it intersects with the footing and the shear capacity of the panel where it intersects with the post.



Post Section Calculations
Allowable shear stress in masonry is equal to the square root of the uniaxial compressive strength of the masonry S_{ssa} = 7,920 psf (379 kPa).

Calculate the shear stress at the base of the post.

$$S_{req} = \frac{(DWP)(Ta)}{(bs)(ds)}$$

$$= \frac{(11.15\text{ psf})(115.825\text{ ft}^2)\ (144\text{ in}^2)}{(14.625\text{ in})(8.06\text{ in})}$$

= 1577 psf (75.57 kPa) << 7920 psf (379.2 kPa) "OK"

Panel Section Calculations
For the panel section we consider the force applied over the entire panel then divide by 2 to localize the force to one post block wing. The allowable wind shear is based on the available area of the wing, laboratory shear test results of pile blocks, 270 psi, (1.86 MPa) and a factor of safety of 3. Where Aw is the thickness of the post wing multiplied by the block height.

Aw = 2.75 in. (70 mm) x h

Allowable wing shear:

$$S_{wing} = \frac{270\text{ psi }(Aw)}{(3)(h)}$$

S_{wing} = 2970 lb/ft (21.27 kN/m)

The calculated shear at each wing is a follows:
Area of the Panel only:

$$Awpanel = (H)(Ps - Pl)$$

= (7.98 ft)(14.51 ft - 1.4688 ft)

= 104.1 ft² (9.67 m²)

The applied shear:

$$S_{wreq} = \frac{(0.5)(DWP)(Awpanel)}{H}$$

$$= \frac{(0.5)(11.15\text{ psf})(104.1\text{ ft}^2)}{7.98\text{ ft}}$$

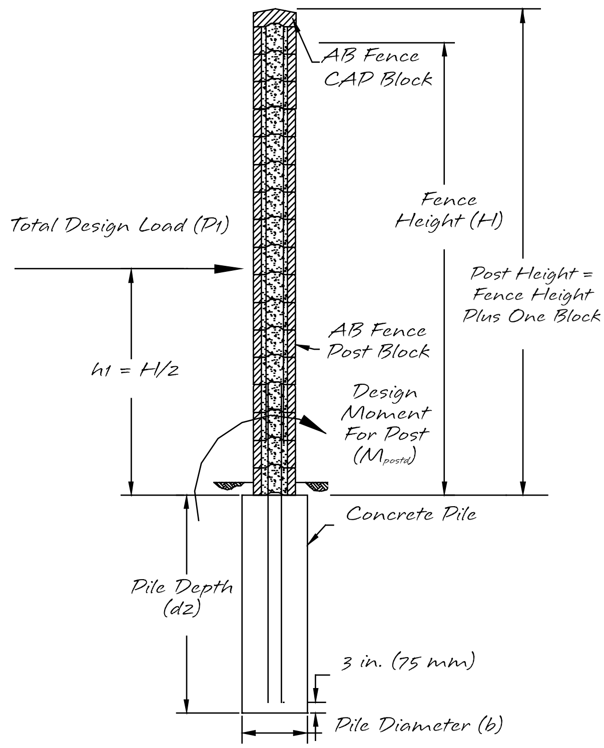
= 73 lb/ft (1061 N/m) << S_{wing} = 2970 lb/ft (21.27 kN/m) "OK"

Design Example

Footing Design

The foundation for the AB Fence system in this manual is a basic 2 ft (0.61m) diameter concrete pile. Using the following equation and an iterative process a footing depth can be obtained.

On page 13, we estimated the size of the footing and determined a weight of footing to calculate a resistance due to its selfweight. Using the footing's selfweight we calculated a design moment for footing design ($M_{footing\ design}$).



$$P_1 = \frac{M_{footing\ design}}{(0.5)(H)}$$

$$= \frac{2295.5\text{ lb-ft}}{(0.5)(7.98\text{ ft})}$$

$$= 584.36\text{ lb} \quad (2.6\text{ kN})$$

Where P_1 is the footings design moment translated into its force vector at the mid height of the panel.

The required depth is determined by the following equation:

$$d = \left(\frac{A}{2}\right)\left(1+\sqrt{1+\frac{4.36h_1}{A}}\right)$$

where: $$A = \frac{(2.34)(P_1)}{(S_{factored})(d_2)(b)} = 2.279\text{ ft } (0.69\text{ m})$$

And: h_1 = the distance in feet from the ground surface to the point of application of P_1

$$= H/2 = 3.99\text{ ft} \quad (1.22\text{ m})$$

Therefore: $$d = \left(\frac{2.279\text{ ft}}{2}\right)\left(\sqrt{1+\frac{(4.36h_1)(3.99\text{ft})}{2.279\text{ ft}}}\right)$$

$$= 4.488\text{ ft } (1.37\text{ m}) < 4.5\text{ ft } (1.37\text{ m}) \quad \text{"OK"}$$

If the estimated footing size was not adequate the designer should increase the footing depth or reduce the tributary area and rework the above calculations. It is an iterative process to fine tune a footing design. The designer should decide during the iteration process whether they will increase the selfweight resistance due to the larger footing or use the initial calculated value which would be lower and conservative.

Soil Retention

The Allan Block Fence system is capable of retaining soil as long as the designer accounts for the additional lateral forces the retained soil exerts on the system. Small levels of retention can be worked into the example above by simply calculating the lateral earth pressure and applying it to the Post overturning moments. Please note that all courses associated with soil retention must be constructed as bond beams, with horizontal steel, sand-mix grout and vertical stirrups. The rigid nature of the bond beams will transfer all soil forces to the posts and footing. During the soil retention design the designer may need to reduce the post spacing to meet the capacity of the pilasters.

For this example we will assume the following for soil retention and soil parameters:

Soil height	H_s	= 3 ft (0.91 m)
Internal Friction Angle	ϕ_i	= 30 degrees
Unit Weight of soil	γ_i	= 120 pcf (19 kN/m^3)

For a more in depth review of soil retention and associated methodologies review the Engineering Manual for Allan Block Wall Systems.

Calculations for static lateral earth pressure coefficient (K_a):

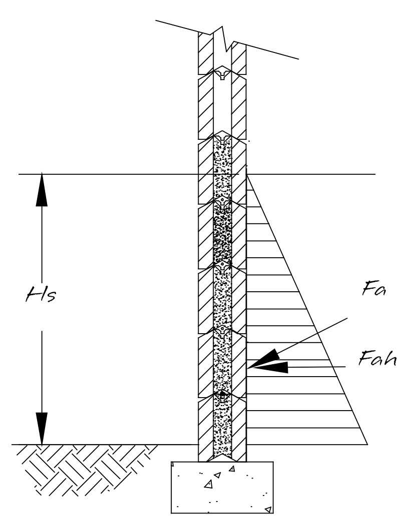
Wall Batter	β	= 90 degrees	
Weighted Friction Angle	ϕ_{wi}	= (2/3)(ϕ_i)	= 20 degrees

$$K_a = \left[\frac{csc(\beta)\sin(\beta - \phi_i)}{\sqrt{\sin(\beta + \phi_{wi})} + \sqrt{\dfrac{\sin(\phi_i + \phi_{wi})\sin(\phi_i - i)}{\sin(\beta - i)}}} \right]^2$$

Where i = back slope angle

NOTE: Typically in AB Fence projects the back slope would equal zero or fall away for drainage.

Active Earth Force: $F_a = (0.5)(K_a)(\gamma_i)(H_s^2)$
$= 160.55$ lb/ft (2343.0 N/m)



Because the soil is applying the lateral force, it is split into horizontal and vertical force vectors but we ignore the vertical component because it does not apply force directly to the wall.

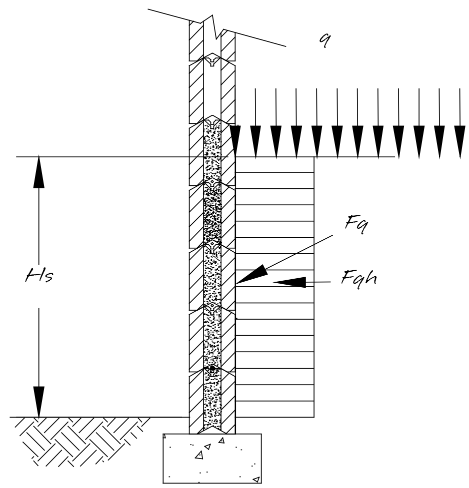
Horizontal force: $F_{ah} = (F_a)[\cos(f_{wi})]$
$= 150.87$ lb/ft (2201.7 N/m)

Determine the overturning moment due to soil retention (Mah):

$M_{ah} = (F_{ah})(P_s)(H_s / 3)$
$= 2189.22$ lb-ft (2968.2 N-m)

This value would then be added to the wind overturning forces and applied to the post structure.

Soil Retention



For AB Fence structures with surcharges above the retained portion such as sidewalks the design process is similar to the lateral earth pressure calculations. You must first determine the horizontal force vector for the surcharge.

Surcharge Force: $F_q = (q)(K_a)(H_s)$

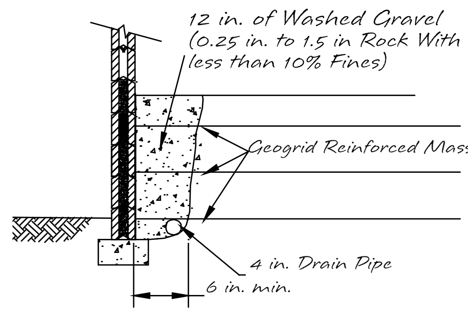
Where: q = the Live Load Surcharge.

For this example: q = 100 psf (4.8 kPa)
Therefore: F_q = 89.19 lb/ft (1301.7 N/m)
Horizontal force: $F_{qh} = (F_q)[\cos(\phi_{wi})]$
= 83.8 lb/ft (1223.2 N/m)

Determine the overturning moment due to surcharge above soils retention (M_{qh}):

$$M_{qh} = (F_{qh})(P_s)(H_s / 2)$$
$$= 1824.4 \text{ lb-ft} \quad (2473.5 \text{ N-m})$$

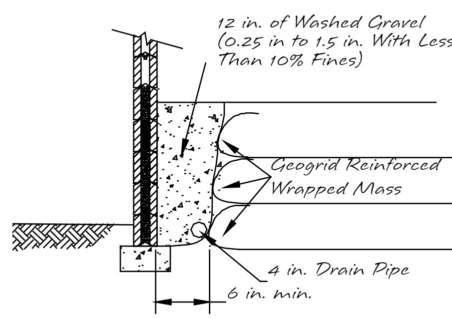
This value would then be added to the wind overturning force and applied to the post structure.



Geogrid Reinforced Mass

Soil Retention with a Geogrid Reinforced Mass

A designer can greatly increase the amount of soil retention using a geogrid reinforced or no fines concrete mass behind the AB Fence. Reinforced soil or no fines concrete masses can be constructed to do all the work in retaining soil. As with an Allan Block retaining wall these masses develop enough weight to resist the applied forces from the retained soils and surcharges. The designer can design a mass sufficient to resist all applied loads and transfer a very small amount of force to the AB Fence structure.



Geogrid Reinforced Wrapped Mass

There are two ways to construct a geogrid reinforced soil mass. The first is to build the entire fence in place and then backfill the retained side in no more than 8 in. (200 mm) lifts, placing the design lengths of geogrid in at the design location, not to exceed 16 in. (400 mm) spacing. The first 12 in. (300 mm) of infill soil up against the fence must be washed gravel to promote drainage behind the fence and must be compacted after each lift of soil is placed. In this type, the geogrid would butt up to the back side of the fence and make no physical connection to the fence. The only forces transferred to the fence are minor compaction forces during construction.

The second way is the reinforced mass is constructed prior to the fence as a Geogrid Reinforced Wrapped Mass. After the fence is constructed the only forces applied to the fence is the bin pressure of the washed gravel placed between the fence and the wrapped mass face.

A no fines concrete mass can simply be placed after the AB Fence is constructed to full height. The designer will simply design the NFC mass appropriately for the desired site conditions and surcharges.

APPENDIX 1:
Intermediate Column & Other Constructability Enhancements

Intermediate Column

During Full-Scale Panel Flexural Testing of longer panels, an aesthetic issue of large deflections at the center of the panel was noticed under extreme loads. As the loads increased on the panel, the center of the panel started to bulge out. This bulge would not completely rebound even though the bond beams would rebound to their initial conditions once the loads were removed. The center column is simple to construct since it consists of adding a single vertical rebar running through the cores of the dry stacked panel block. These vertical cores are then filled with a fine sand-mixed concrete grout matching that used in the bond beam. It is not required to have the intermediate column extend into the bond beams located above or below. During testing, when the center column was added the bulge was eliminated after the loads were removed and the panel rebounded. It was also recorded that the load transfer to the posts was not affected by adding the center column. Since the large deflections were only noticed on the longer panel spacing, it is Allan Block's recommendation that the intermediate column (Figure 12) be used only in panels with a post spacing greater than 15 ft long (4.6 m).

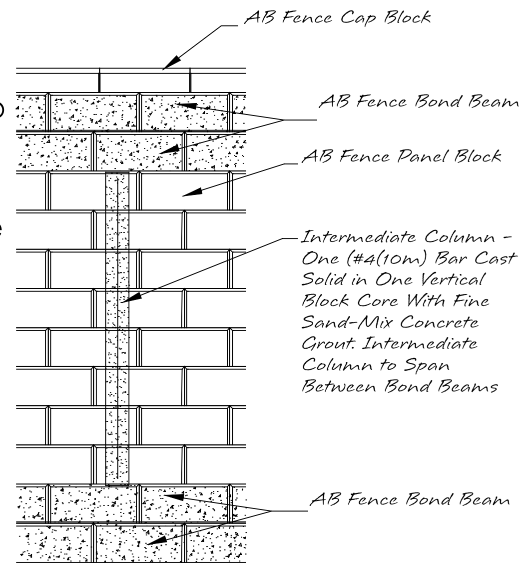


Figure 12 : Intermediate Columns

Unreinforced Leveling Pad

The AB Fence system requires a leveling pad be placed prior to construction of the panel. The typical leveling pad is a compacted aggregate pad. Some contractors may choose to construct an unreinforced concrete leveling pad (Figure 13) instead of the compacted aggregate pad. An unreinforced concrete leveling pad can aid the contractor in leveling the base course, especially in longer panels. Allan Block would recommend the use of an unreinforced concrete leveling pad in fences with post spacings exceeding 15 ft (4.57 m) long but one could be used in all AB Fence application if the contractor chooses.

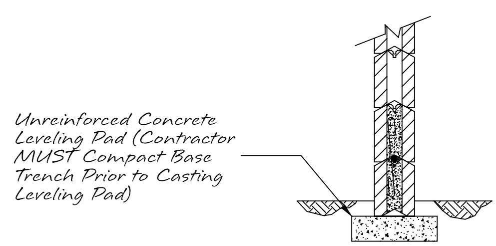


Figure 13 : Unreinforced Concrete Leveling Pad

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AB Fence Testing Manual - F0205

Installation Manual for the AB Fence System - F0209

ABC/Stork TCT 4.0' - 8.0' x 11.5' Solid Spreader Frame Test

ABC/Stork TCT 8.0' x 11.5' Articulating Frame Test

ABC/Stork TCT 8.0' x 17.6' Articulating Frame Test

ABC/Stork TCT 8.6'AB Fence Post Flexural Test

Additional Resources

Visit our web site at allanblock.com for the latest information on the AB Fence system. Check out our:

Installation Guide and Tech Sheets

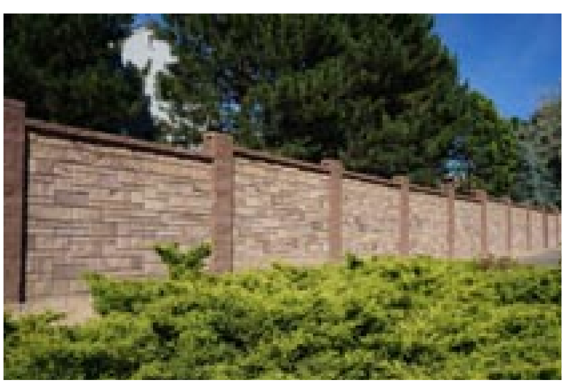
Estimating Tool

Product Testing Results

Design Details

Project Photography

and much more...



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For more information on AB Fence visit our web site or call the Allan Block Engineering Department at 800-899-5309.

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