train design support care

Technical support

ACO has an established Technical Services Department with engineers and support staff offering many years experience advising on surface water management.

These free services are offered with no obligation and are supported with extensive, high quality information, literature and project specific technical documentation.

Technical support falls into four areas:

1 Application

Trench drains are designed to collect and remove surface water. Failure is usually due to application issues. If the product 'physically' fails, replacement is essential. The priority is to address where and how the product will be used to ensure long service life.

1a) Loading

Loads influence pavement design and as the trench system is an integral part of the pavement, the correct installation detail is critical to product longevity.

A summary and comparison of commonly referenced Load Standards is provided on pages 128-129.

Installation details

SERVICE A - ACO can supply:

- *Advice on application load class*
- *Load test certificates*
- *Installation section details*

1b) Site requirements

There are a variety of materials used in trench drain systems. A summary of each is provided on pages 136-137.

Each material behaves differently in various environments and situations. ACO can provide advice on chemical and corrosion resistance for most common trench drain materials.

Non-metallic and environmental (SD, LID, LEED) considerations may also impact product choices. ACO can assist in these decisions as well.

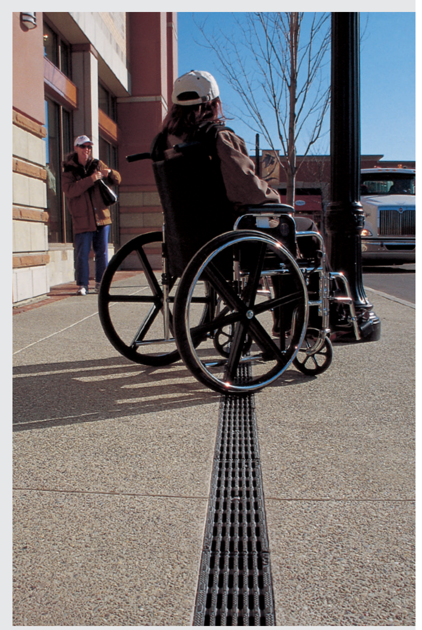
Material data

SERVICE B/C - ACO can supply:

- *Material coupons (samples) for on site testing*
- *Material test reports*

1c) User requirements

ACO provides specific product documentation indicating the standards each complies with.



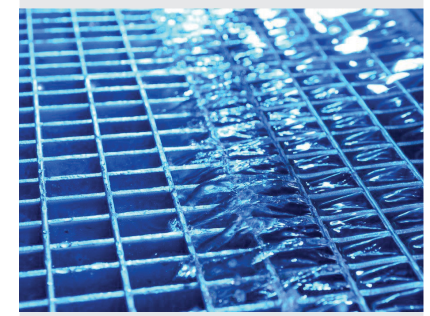
Supporting documentation

SERVICE D - ACO can supply:

- *Industry standards/requirements and 3rd party test data, where relevant*

2 Hydraulics

Hydraulics covers trench drain functionality and failure isn't always apparent. Use of an undersized or oversized trench drain can have major cost and liability consequences, particularly in applications where flood damage to property or personal risk are of concern.



ACO offers several project specific hydraulic support services to accurately determine the most hydraulically efficient and cost effective trench drain size and layout.

Trench hydraulics - Hydro

SERVICE E - ACO can supply:

- *Hydraulic liquid profiles for individual trench runs*
- *Liquid depth profiles at design conditions*

Trench hydraulics - Ponding

SERVICE F - ACO can supply:

- *Map of temporary ponding*
- *Approximate duration of any temporary ponding*

Grate hydraulics - GIC

SERVICE G - ACO can supply:

- *Grate performance dependent on location with crossfalls*

3 Trench layout

Modular trench runs can be complex and ensuring the correct materials can be time consuming, particularly where multiple trench runs are involved. In addition, once materials arrive on site, determining what pieces go where can be a challenge. ACO offers several services to ensure this part of the process runs as smoothly and efficiently as possible.

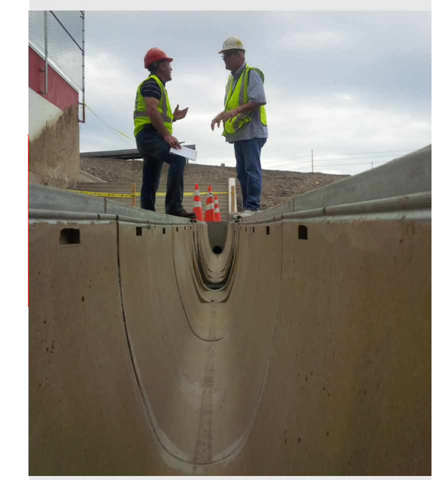
Trench layout documents

SERVICE H - ACO can supply:

- *Plan layouts of trench runs (CAD)*
- *Section layouts of trench runs showing modular sequence of channel units*
- *Bill of Materials (BOM) - fully itemizing parts and pieces*

4 Installation support

Even the right product can fail if incorrectly installed. Therefore, to ensure your trench drain investment performs as expected, getting the installation right is important. ACO has an in-house team of engineers qualified to offer advice on most installation issues, such as size of concrete surround, haunch details, installation method options, etc.



Installation guidance

ACO can supply:

- *Installation section details by product type, pavement type and loading type*
- *Consultation on specific installation concerns*

Current US load standards

A number of US standards make reference to grate loading. There is no current standard that specifically deals with trench drains of different widths.

Where possible, to enable comparison between the loading specified within each standard, equivalent stresses (psi) are calculated from the specified test load and test block size of each standard.

To assist with applying these standards to ACO products, a guide is provided below equating stresses (psi) to the Load Class A - F categories from EN 1433 : 2002 Drainage channels for vehicular and pedestrian areas. It is also broken down by internal channel widths.

Load class certification for each product is available upon request.

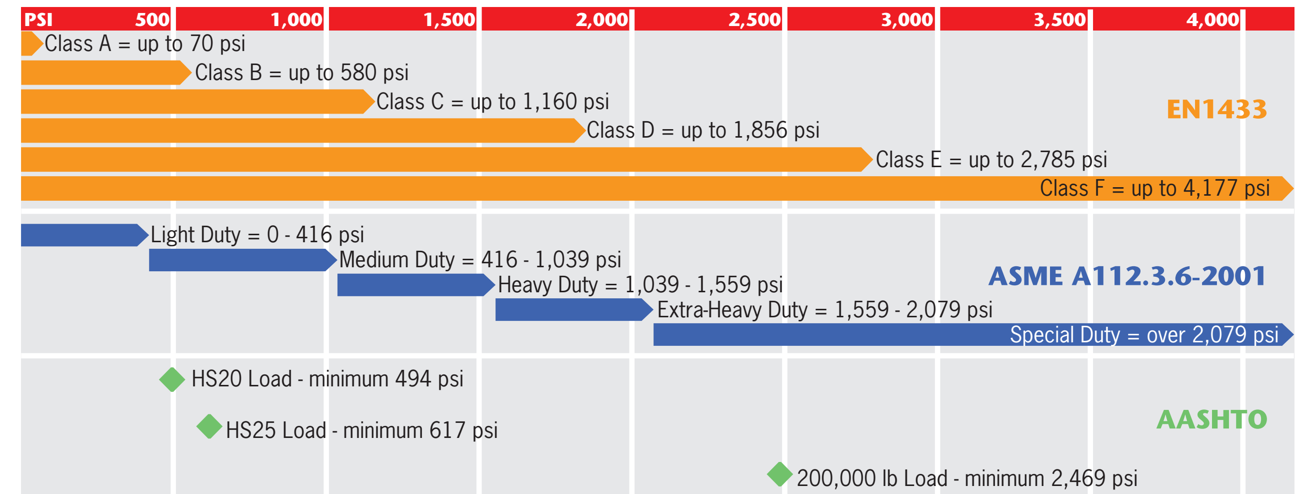
Common standards in North America:	EN 1433 Load Class of similar or equivalent rating: Internal channel width 4<8"	8<12"	>12"
ASME: A112.6.3 - 2001			
Plumbing standard relating to internal floor drains.			
Light Duty (Live Load < 2,000lb)	A - B	A - B	A - C
Medium Duty (2,000lb < Live Load < 4,999lb)	B - C	B - D	C - D
Heavy Duty (5,000lb < Live Load < 7,499lb)	C - D	D	D - E
Extra Heavy Duty (7,500lb < Live Load < 10,000lb)	D - E	E	E - F
Special Duty (Live Load > 10,000lb)	E - F	E - F	F
AASHTO Standard Specification for Highway Bridges			
Standard relating to design for bridges. Loadings are dealt with by wheel 'footprints' and axle ratings. No specification is given for measurement of the performance of trench drains.	HS20		
	C* - F	C - F	E - F
General specifications relate to vehicle loading up to HS20/HS25. Maximum truck weight 90,000lbs - 3 axles.	HS25		
	C - F	C - F	E - F
200,000lb proof load			
The lack of a very heavy duty test standard created the need for a 'line of measurement'. Manufacturers of cast iron access covers used the structure of the RR-F-621E standard with 9" x 9" test block, but promoted the use of a 200,000lbs proof load - 2,469psi. Although no independent standard refers to this measure, it has become widely accepted as a 'line of measurement' for very heavy duty loadings.	F	F	F
FAA AC: 150/5370-10 - Item D-751			
Airport standard that covers manholes, catch basins and inspection holes. No measurement or specification given for testing.	*Insufficient data*		
FAA: 150/5320-5B & 6D			
Standard relating to airport drainage and pavement designs. Loadings up to 100,000lbs, but no specific test procedure specified.	*Insufficient data*		
AASHTO: M306 - 10 Drainage Structure Castings			
Standard relating to castings in roadways	*See HS20 / HS25*		

* Although the chart indicates that the minimum psi for HS20 falls into the top of Load Class B range, ACO strongly recommends using Load Class C or higher due to the volume and dynamic nature (speed, turning & braking) of traffic in typical HS20 applications.

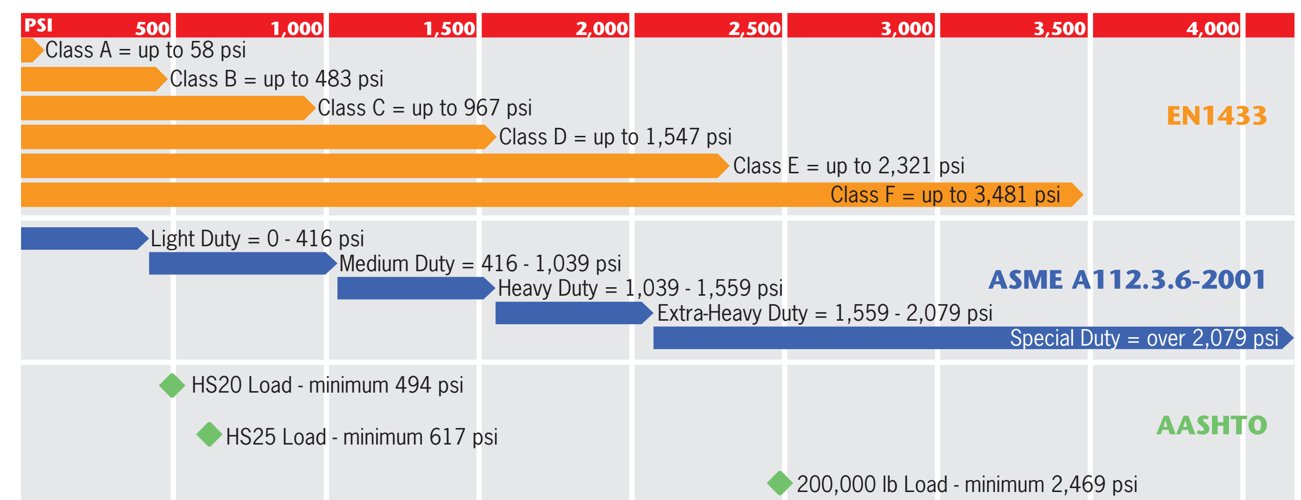
Load standard comparison chart

Pounds per square inch (PSI) comparison of load testing

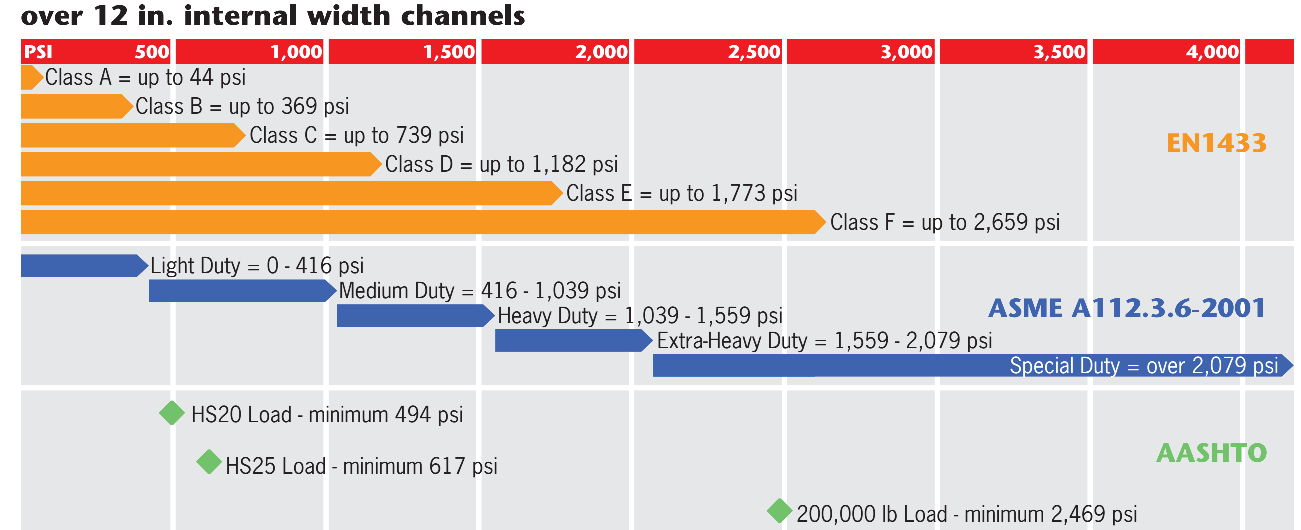
4 in. - 8 in. internal width channels



8 in. - 12 in. internal width channels



over 12 in. internal width channels



1.a Application - Loading

Load Class A - 3,372 lbs - 15kN (44-70 psi)

Residential and light pedestrian traffic

Load Class B - 28,100 lbs - 125kN (369-580 psi)

Sidewalks and small private parking lots

Load Class C - 56,200 lbs - 250kN (739-1,160 psi)

Parking lots and general commercial areas

Load Class D - 89,920 lbs - 400kN (1,182-1,856 psi)

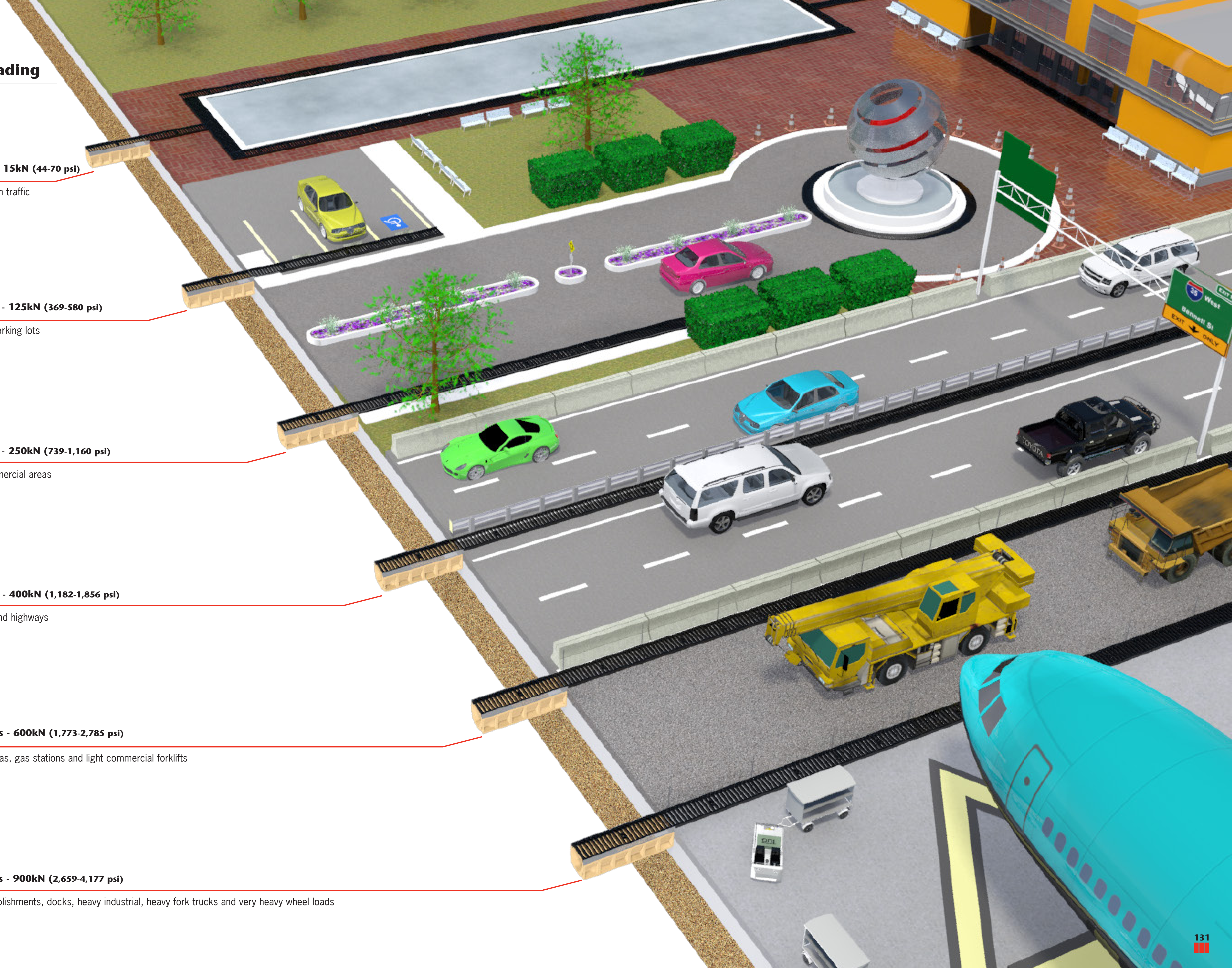
Trafficked sections of roads and highways

Load Class E - 134,800 lbs - 600kN (1,773-2,785 psi)

Aircraft hangars, industrial areas, gas stations and light commercial forklifts

Load Class F - 202,320 lbs - 900kN (2,659-4,177 psi)

Aircraft runways, military establishments, docks, heavy industrial, heavy fork trucks and very heavy wheel loads



Load testing

EN 1433

The only standard written specifically for trench drains, and internationally recognized, is EN 1433: 2002 Drainage channels for vehicular and pedestrian areas.

EN 1433 accounts for different widths of grates. For trench drains less than 200mm wide, test block for load testing is 10" long by 3" wide. For trench drains 200mm to 300mm wide, test block is 10" long by 6" wide; for trench drains over 300mm, the test block is 10" diameter. This ensures that the full force of the test load is directed onto the grate.

EN 1433 also prescribes testing methods for system testing (the complete trench drain and grate). It accounts for both proof loading and catastrophic failure.

EN 1433 also outlines system testing for monolithic trench drains (grate and body manufactured as a single unit). See ACO Infrastructure for monolithic trench drains.

EN 1433 load test - with width specific test block

Diagrams show test load applied to typical grates through an EN 1433 prescribed width specific test block. Test blocks are sized to ensure the entire test load is applied to grate NOT grate supports - this ensures relevant results for all trench drain widths.

Grate for 4 in. internal width trench drain

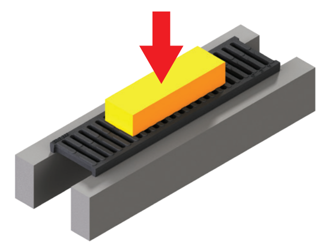
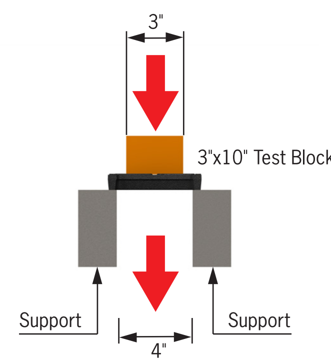


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



Grate for 8 in. - 12 in. internal width trench drain

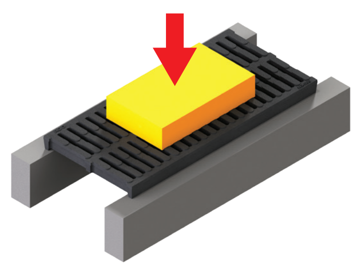
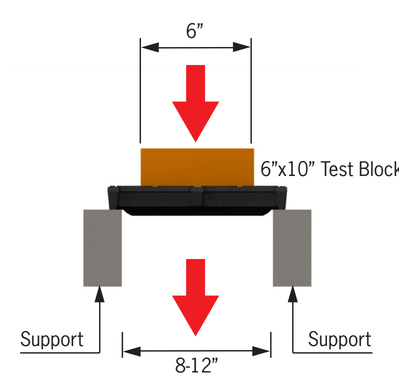


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



Grate for over 12 in. internal width trench drain

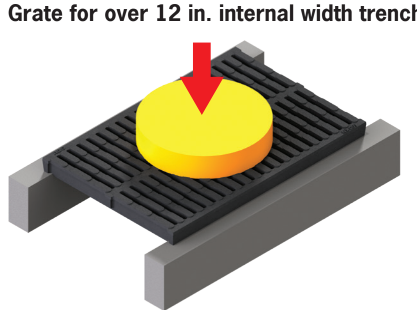
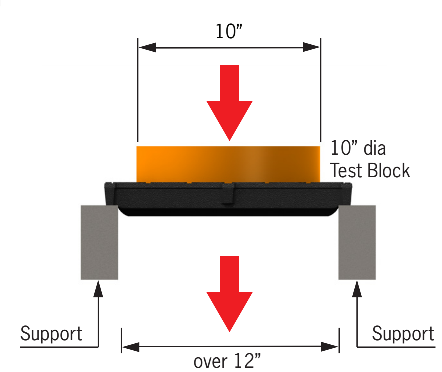


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



ASME: A112.6.3 load test - 3.5 in. dia. test block

This load standard is designed for small internal floor drains and prescribes a smaller (3.5" dia.) test block therefore exerting entire test load into the grate, providing relevant results for all trench drain widths.

Grate for 4 in. internal width trench drain

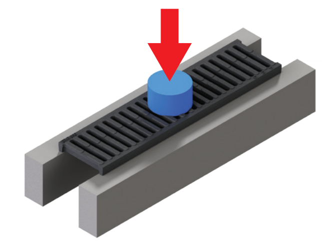
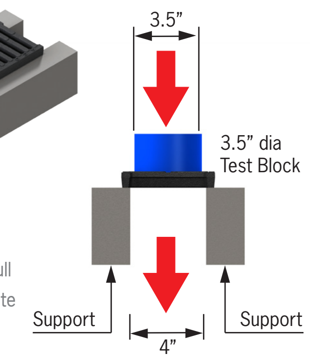


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



Grate for 8 in. - 12 in. internal width trench drain

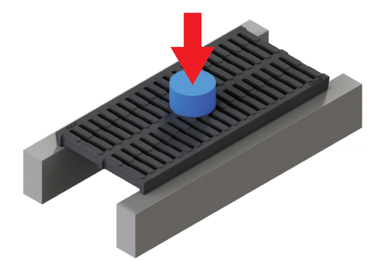
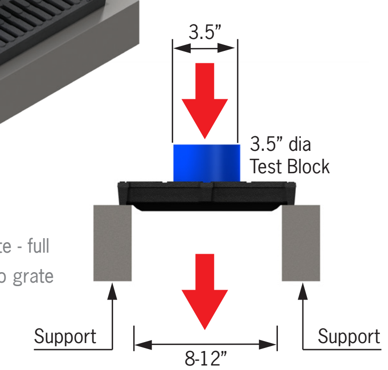


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



Grate for over 12 in. internal width trench drain

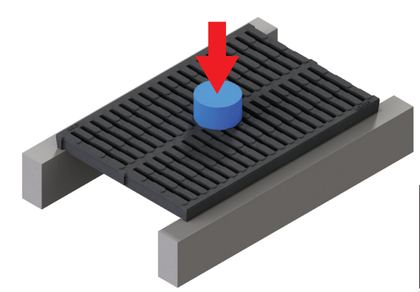
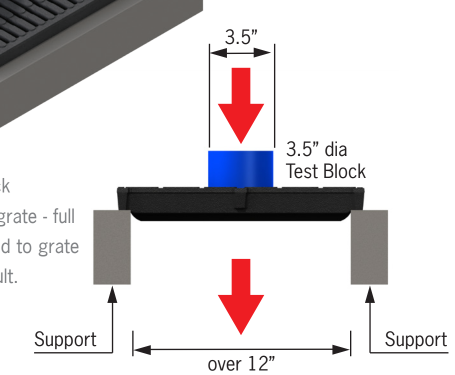


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



AASHTO load test - 9 in. x 9 in. test block

Diagrams show test load applied to grates through a 9" x 9" (225 x 225mm) test block. At 4" and 8" widths, grate is NOT tested - the load is taken by supports rather than grate - results from these tests are questionable. Only at 12" and wider is grate being tested and relevant results will be provided.

Grate for 4 in. internal width trench drain

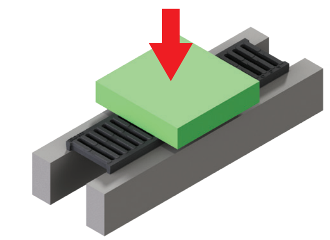
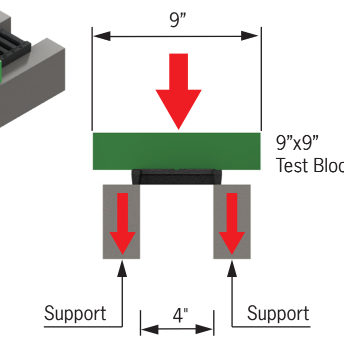


Diagram shows test block positioned centrally on grate - full test load is NOT being applied to grate giving an unreliable result.



Grate for 8 in. - 12 in. internal width trench drain

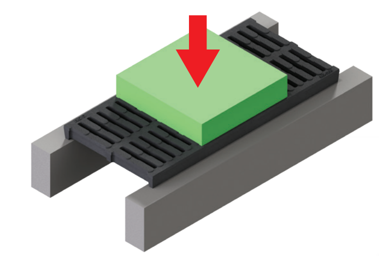
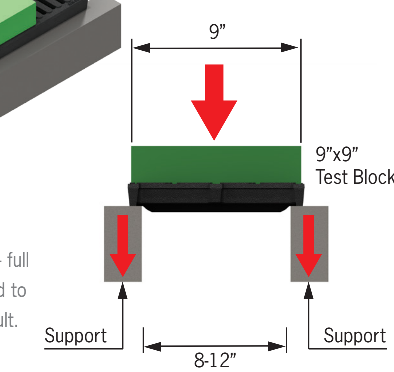


Diagram shows test block positioned centrally on grate - full test load is NOT being applied to grate giving an unreliable result.



Grate for over 12 in. internal width trench drain

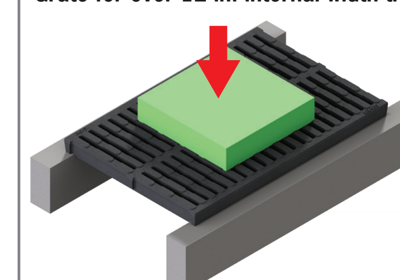
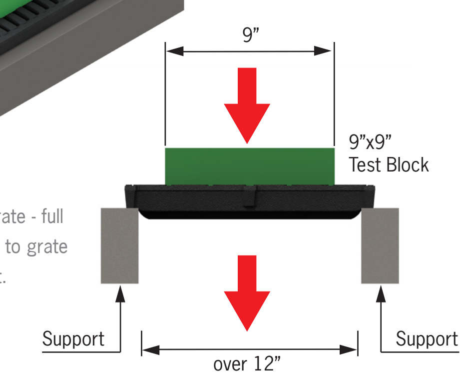


Diagram shows test block positioned centrally on grate - full test load is being applied to grate giving a meaningful result.



Loading - often referred to as traffic - is any weight that will rest on, or travel over, the trench drain.

Traffic includes pedestrians, livestock, machinery and vehicles - basically anything that will be going over the trench drain.

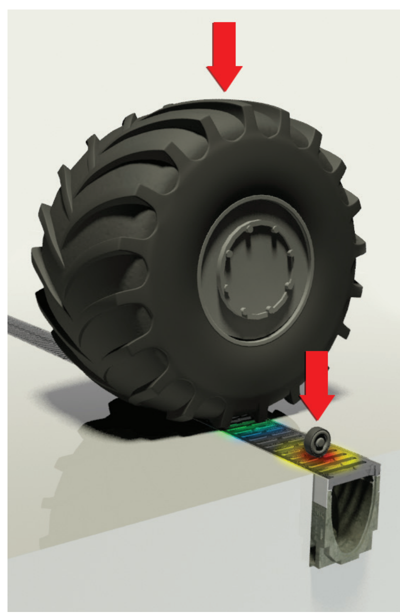
Traffic is the most important factor in pavement design. A trench drain is an integral part of the pavement. Therefore, traffic is also the number one consideration when determining the type of trench drain (both channel and grate) and the concrete encasement required for each application.

During the construction phase it will be necessary to protect the trench from site traffic. *See page 154 for details.*

Factors affecting loading

Contact area

Contact area between load and trench drain grate affects pressure (psi) exerted by load. Typically relates to tire type, but can include anything that may rest permanently or periodically on trench drain.



Small and/or solid tires concentrate load onto a small contact area - exerts a higher pressure (psi). This application requires grate and/or trench system with higher load rating.

Larger and/or pneumatic tires spread load over larger contact area - exerts lower pressure (psi).

Wheel loads

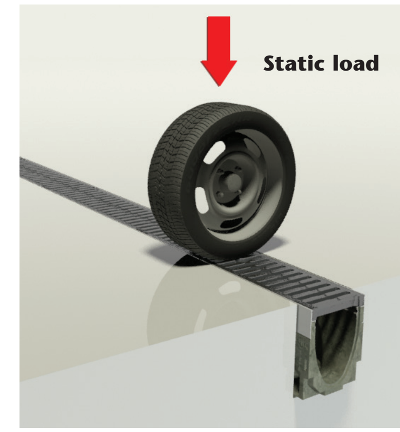
Combined with contact area to calculate loading.

- *Weight of vehicle/cart and its typical load, eg. forklift & weight of typical loaded pallet*
- *Number of wheels and axles that load is distributed over, affects individual wheel load*
- *Unusual traffic, e.g. dollies/dumpsters going over trench*

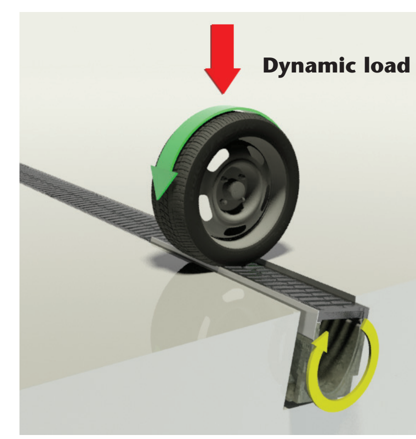
Load frequency

It is also important to consider how often load is applied. Frequent or continuous loads will require heavier duty trench drain and/or larger concrete encasement detail than occasional loads of same weight.

Dynamic vs static loads



Static loads are a load/weight applied vertically onto the trench - no other movement. Not typically found in real life scenarios, but are used for load testing a grate or trench drain. They provide an objective measuring scale to rate loadings of grate/trench drain.



Dynamic/moving loads - forces rise rapidly as traffic speed increases. Factors that intensify dynamic loading include:

- *Vehicles traveling across or along trench*
- *Traffic braking, accelerating or turning on trench*
- *Speed of traffic*
- *Trench located at top or bottom of a ramp*

Forces created by dynamic loads tend to twist trench drain and grates out of position. The more movement (turning and/or braking) and/or faster traffic, the greater the dynamic load. Trench body, grate type, installation detail, and locking mechanisms, are all important factors to consider when addressing dynamic loads.

Installation details - Loadings

Load categories

To assist product selection, ACO independently tests each channel and grate to an internationally recognized load standard - EN 1433. Results are categorized into 6 classes from light duty - 'A' to heavy duty - 'F'.

ACO offers advice on the most appropriate load class. An overview, and comparison of EN 1433 and other commonly referenced US load standards is provided on pages 128-129.

To advise on most appropriate Load Class, the following information is required:

- *Type of traffic*
- *Location of trench - bottom of ramp, alongside building, etc.*
- *Wheel type, if appropriate*
- *Vehicle/cart weight and weight of typical load*
- *Typical vehicle speed*
- *Traffic flow pattern - along or across trench? Turning or braking on trench?*
- *Unusual traffic - snow plows, dumpsters, etc.*

Concrete surround

Loading will also impact the size of concrete encasement required. It is recommended that the cement concrete encasement be durable and conform to minimum strength requirements shown in ACO's recommended installation detail.

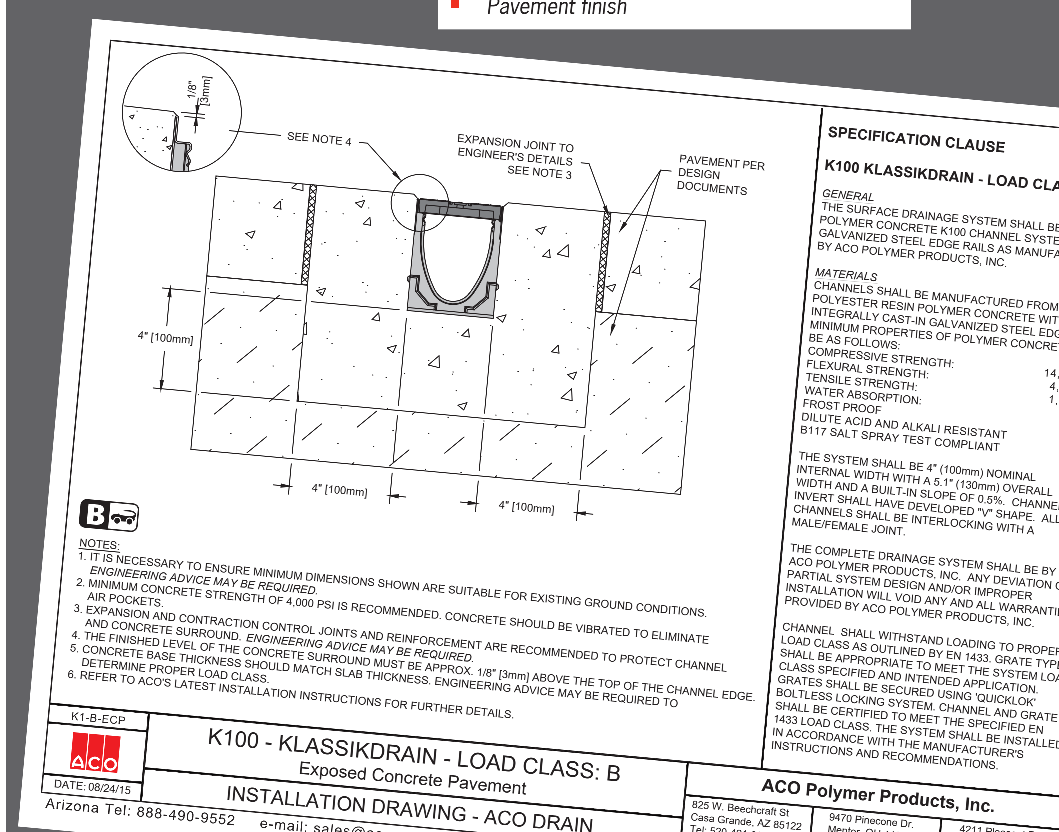
Poor site conditions and low load bearing pavements will require an increase in these dimensions to meet both vertical and lateral loads.

Some applications will also require concrete reinforcement.

Always seek engineering advice for specific applications.

To select correct section detail, the following information is required:

- *Load class*
- *Product type & width (e.g. KlassikDrain K200)*
- *Pavement finish*



Trench materials

Modular trench drain systems are generally manufactured from polymer concrete, fiberglass or HDPE (High Density Polyethylene).

ACO Drain commercial trench systems are manufactured from either polymer concrete or fiberglass. Other materials do not meet the compressive strength and thermal expansion properties required in commercial and industrial projects. ACO uses plastics primarily as a grate and trench material for residential applications (ACO Self).

Polymer concrete

Polymer concrete is a composite material produced by mixing mineral aggregates with a resin binding agent. The finished material has excellent mechanical and thermal properties and offers good corrosion resistance to many chemicals. A maximum working temperature of 180°F (82°C) is recommended.

Due to their structural rigidity, polymer concrete trench drains can be used in a variety of pavement types such as concrete, asphalt and brick pavers.

Fiberglass

Fiberglass uses similar resin binding agents to those used for polymer concrete, but glass mat and fibers are used instead of mineral aggregates to provide a robust flexible material.

Fiberglass trench drains are designed to be fully encased in concrete.

Cement concrete

Cement concrete is Portland cement mixed with mineral aggregates. Generally used for large cast-in-place slab applications, where mass is required for structural rigidity.

Expanded polystyrene formers have disposal concerns, and are often released using gasoline. Local EPA regulations should be complied with.

Plastics

The most common plastic used in a trench drain is polyethylene - usually HDPE (High density PE) or MDPE (Medium density PE). Both HDPE & MDPE are readily available, economical materials that are easy to mold.

Plastic trench drains are designed to be fully encased in concrete, however, HDPE/MDPE have thermal properties that require the addition of concrete keying features to securely anchor the product within the concrete slab. Without adequate concrete keying features the trench may lose bond (pull away) from the concrete encasement and buckle, ultimately leading to product failure. This is of particular concern in applications where short term wide temperature ranges are expected, and/or long trench runs are involved.

Metals

Trench drains can also be fabricated from mild or stainless steel. ACO recommends stainless steel trench drains for hygienic applications. See ACO Building Drainage products for details.

A material comparison chart is provided opposite and chemical resistance chart on page 139.

Grate materials

Grates are manufactured from a variety of materials. The most common are ductile iron, mild steel, stainless steel and plastic.

Grates need higher bending strength properties than the trench body to withstand flexural loads. Unlike the trench drain body, grates can be removed and replaced after installation.

In commercial applications, all grates should be locked in place to ensure user safety and channel longevity.

Edge protection

The exposed edge of the trench helps pavement to maintain a visual straight line and helps hold the grate in position. The exposed edge is subjected to the same loads as the grate. In addition to effect of climate and traffic, the edge is exposed to impact from items being dropped or pulled across it (e.g. snow plows). Once the edge fails, the grate will move and cause catastrophic failure.

Metal edges are most commonly used as a wearing rail to withstand rigourous and repetitive traffic. Edge protection rails should be integrally cast-in or mechanically connected to the trench body. Edge rails that sit over existing standard edges are often ill-fitting and susceptible to failure.

Edge rails also provide some protection during installation. Appropriate edge protection is particularly important in asphalt situations where rolling machines can damage exposed edges, leading to premature trench drain failure.

Non-metallic option

Polymer concrete is an ideal material for non-metallic requirements. It offers excellent insulation properties - electrical resistivity rating of 1×10^8 Ω/sq.

H100 is a 100% polymer concrete channel that can be used with non-metallic grates (Types 494Q/495Q - See ACO Sport range) to provide a 100% non-metallic trench drain system.

Call ACO's Technical Services Department for additional suggestions if this is not a suitable solution.

Trench materials - physical properties

Different materials offer different surface and physical performance properties which may affect their suitability of use in various applications. These charts provide a side by side comparison.

Surface properties	Fiberglass	Cement Concrete	Polymer Concrete	Polyethylene HDPE
Surface burning Trench systems are often used around gas stations, chemical processing and interior applications and may be subject to fire; they should be non-flammable and not give off fumes or smoke.	After flame time: 216 seconds - fail UL-94	7 rating E119	Flame spread: 0 Smoke density: 5 E84	After flame time: 390 seconds - fail UL-94
Weathering The majority of trench drains are used in exterior applications. Ability to withstand adverse weather will ensure long service life (erosion, UV degradation etc).	1000hr exposure no change G-153*	[a] Good depending upon proper curing	2000hr exposure no change G-153*	[b] 1000hr exposure no change FAIL G-153*
Roughness Coefficient (Manning's) Any degree of friction will affect liquid flow to an extent, therefore the lowest value is desirable.	n=0.008	n=0.013	n=0.011	n=0.010
Chemical resistance Trench may be used for chemicals - for chemical resistance data see page 139.	Good	Poor	Good	Good
Mechanical properties				
Compressive strength The trench body is subject to compressive loads in use and needs to withstand the specified load.	24,400psi D-695	4,500psi C-39	14,000psi C-579	8,450psi D-695
Flexural strength Affects site handling and when trench body is in areas where encasement and soils are suspect.	9,943psi D-790	587psi C-78	4,000psi C-580	2,224psi D-790
Bending strength Not generally required in trench bodies, but relevant to grates. Used as material measurement.	7,378psi D-638	[c] 419psi	2,000psi C-307	1,993psi D-638
Thermal properties				
Water absorption The trench is designed to carry and collect liquids without contaminating surrounding soil/encasement.	+0.33% D-570	+5.00% C-97	+0.07% C-97	+0.31% D-570
Freeze-thaw Inability to withstand freeze-thaw cycles causes surface spoiling and leads ultimately to trench failure.	223 cycles modulus of elasticity 89.5% C666	300 cycles maintain 80% structural integrity	300 cycles modulus of elasticity 95.1% C666	223 cycles FAILED modulus of elasticity test C666
Coefficient of expansion/contraction Excessive movement between trench and trench surround creates debonding, causing unwanted stresses and possible failure.	[d] $6\text{-}17 \times 10^{-6}$ per °F D696-03	6.5×10^{-6} per °F D696-03	11.0×10^{-6} per °F D696-03	54.0×10^{-6} per °F D696-03
Water vapor transmission WVT is measurement of water vapor flow through a material. Passage of water vapor may be critical.	WVT - 0.109g/m^2 1,592hrs E96	See water absorption test	WVT - 0.036g/m^2 1,592hrs E96	WVT - 0.139g/m^2 1,592hrs E96

Key

a. Carbonation can affect steel rebar leading to poor weathering (PCA Design & Control of Concrete Mixtures - 14th ed).
b. Bending exceeded 5% strain - unable to complete test.
c. Equals 6.25 x √ compressive strength (psi) - (PCA Design & Control of Concrete Mixtures - 14th ed).
d. Variance due to many manufacturing processes for fiberglass - FG200 falls into the higher part of the range.
* Test was done to prior standard but procedure requirements were identical.

Sustainable drainage

In an environmentally perfect world permeable landscapes would be everywhere, allowing nature to work as intended. However, in reality, this is not possible and hard landscapes are common.

Sustainable drainage is the collection of rainwater, its treatment and, ultimately, its reuse.

The process involves collecting water runoff (that may or may not contain pollutants) and allowing it to be dealt with in a controlled manner - i.e. treated, stored for future use, or discharged to receiving waterways, ideally at low cost, and with minimal impact to the environment.

Surface drainage can be used to assist the 'collect' part of this process. Trench drains are ideal as they provide maximum collection and can form a barrier to prevent runoff flowing onto sensitive areas or soft landscaping. This is particularly important if the toxicity risk of pollutants is high, such as highway and gas station applications.

EPA requirements

Stormwater runoff is generated from rain and snowmelt events flowing over land or impervious surfaces, and not percolating into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the runoff is discharged untreated.

The primary method to control stormwater discharges is the use of Best Management Practices (BMPs). In addition, most stormwater discharges are considered point sources and require coverage under an NPDES permit.

LEED

Leadership in Energy and Environmental Design provides a green building rating system. Principles have been applied to commercial and institutional projects, schools, multi-unit residential buildings, manufacturing plants, laboratories and other building types.

Areas where the use of trench drainage may assist in assignment of credits include:

SUSTAINABLE SITES
- Protect or Restore Habitat
Compared to catch basins, trench drains require minimal excavation; reducing site restoration requirements.

- Rainwater Management
Trench drains offer maximum capture of run-off, allowing for on-site nonpotable uses such as irrigation. Run-off can also be quality assessed and treated as required.

WATER EFFICIENCY
- Water Use Reduction
Reclaimed water/Alternative water source - use of trench drains to capture rainwater for future irrigation/toilet flushing use to achieve increased water use reduction.

MATERIALS & RESOURCES
- Construction & Demolition Waste Management
To reduce construction and demolition waste disposed of in landfills and incineration facilities by recovering, reusing, and recycling materials.
Compared to catch basins, trench drains require minimal excavation; reducing site waste/debris.

*Go to **www.usgbc.org** for full details.*

Hydrocarbons

clean

Stormwater run-off frequently carries the risk of containing hydrocarbons. Trench drains in high risk areas; i.e. gas stations and airports almost always drain into oil-water separators. Refer to ACO Environment for details.

ACO now offers solutions for hydrocarbons to be removed at the outlet - these solutions are ideal for applications where the risk is lower, and/or where space does not allow for the use of an independant oil-water separator. Call ACO for details.

Chemical resistance

ACO Drain channel bodies are highly resistant to chemical attack and, with the appropriate grate, can be used in most environments where everyday acids and dilute alkalis are encountered.

Important considerations for chemical environments

When reviewing potential applications of trench drains in chemical environments, the following issues should be considered:

1. Type(s) & mixture of chemical(s).
2. Concentration percentages.
3. Contact time with trench system.
4. Temperatures of chemicals flowing into the trench drain. 180°F (82°C) max.
5. Flushing system employed to clear chemicals from the system.
6. Cleaning agents should be checked for compatibility with trench materials.
7. ACO test coupons can be used for final determination of chemical resistance.
8. Grate, locking mechanism, edge rail, outlet and trash bucket materials should be checked for chemical resistance.
9. Check sealant for compatibility, if applicable.

SERVICE C

support

Chemical resistance chart

These recommendations are for guidance only. They are based upon information compiled from resin plastic manufacturers. Customers are advised to test a coupon of polymer concrete to ensure suitability. Test coupons are available free of charge from ACO.

If ACO Drain standard products are unable to provide adequate chemical resistance, contact ACO (800) 543-4764 for a suitable product solution.

Chemical Medium	Max. conc.	Short time exposure 72 hours	Long time exposure 42 days
Acetic Acid	30%	✓	✗
Acetone	10%	✓	✗
Ammonia	10%	✓	✗
Aniline	100%	✓	✗
Aniline in Ethyl Alcohol	10%	✓	✓
Benzene	100%	✓	✗
Boric Acid	100%	✓	✓
Butyric Acid	25%	✓	✓
Butyl Alcohol	100%	✓	✓
Calcium Chloride	100%	✓	✓
Calcium Hydroxide	100%	✓	✗
Caster Oil	100%	✓	✓
Chloric Acid	5%	✓	✗
Chromic Acid	5%	✓	✓
Citric Acid	100%	✓	✓
Diesel Fuel	100%	✓	✓
Ethanol	100%	✓	✗
Ethlendiamine	100%	✓	✓
Ethyl Acetate	100%	✓	✗
Ferrous Sulfate	30%	✓	✓
Fluorallic Acid	10%	✓	✓
Formaldehyde	35%	✓	✓
Formic Acid	10%	✓	✗
Fuel Oil	100%	✓	✓
Gasoline	100%	✓	✓
n-Heptane	100%	✓	✓
n-Hexane	100%	✓	✓
Hydraulic Oil	100%	✓	✓
Hydrochloric Acid	10%	✓	✓
Hydrofluoric Acid	5%	✓	✗
JP4	100%	✓	✓
JP8	100%	✓	✓
Lactic Acid	10%	✓	✓
Methanol	5%	✗	✗
Methyl Amine	100%	✓	✗
Methyl Ethyl Ketone	100%	✓	✗
Mineral Oil SAE5W50	100%	✓	✓
Monochlor Benzene	0.05%	✗	✗
Monochloroacetic Acid	10%	✓	✓
Nitric Acid	10%	✓	✗
n-Nonane	100%	✓	✓
Iso-Octane	100%	✓	✗
Oxalic Acid	100%	✓	✓
Phenol	100%	✓	✗
Phosphoric Acid	10%	✓	✓
Potassium Hydroxide	10%	✗	✗
Sodium Acetate	100%	✓	✗
Sodium Carbonate	20%	✓	✓
Sodium Chloride	100%	✓	✓
Sodium Hydroxide	15%	✓	✗
Sodium Hypochloric	5%	✓	✓
Sulfuric Acid	40%	✓	✓
Tetrafluoroborsaure	20%	✓	✗
Toluene	100%	✓	✗
Trichloroethylene	100%	✗	✗
Triethylamine	100%	✓	✓
Xylene	100%	✓	✗

Note: Maximum operating temperature of 180°F (82°C)

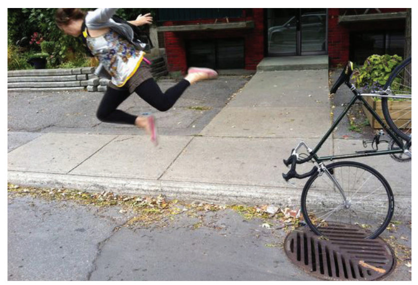
ASTM - B117 Salt Spray Test
ACO polymer concrete has passed independent tests and is unaffected by road de-icing salts. This test is an accelerated corrosion test that produces a corrosive attack to predict a material's suitability in use. The ACO test sample showed no sign of degradation after 1,000 hours of salt spray exposure.

Once trench drain choice has been narrowed by determining loading and durability requirements, options relative to project specific end user needs, or legislative obligations, need to be considered.

ACO can provide product guidance based on current industry standards and requirements. When third party testing has been carried out copies of test certificates are also available.

1. Legislative compliance

Trench drains are commonly used in public areas where accessibility is a concern and ADA legislation must be met. A number of grates are available that provide ADA compliance without compromising aesthetics or performance.



2. User safety

ACO has categorized grate safety into 3 main types:

- Heel resistant - complies with ASME: A112.6.3
- Heel safe - Narrow slots for stiletto heel safety
- Bicycle safe - complies with AS 3996

3. Grate security

ACO recommends that grates should be secured to prevent movement by traffic, which can cause damage to the trench and/or grate.

4. Aesthetics

The top of the trench, usually the grate is the most visible part of the trench drain and aesthetically the most important.

Grates can be selected to blend into the pavement, or used as a feature or border.

5. Slip resistance

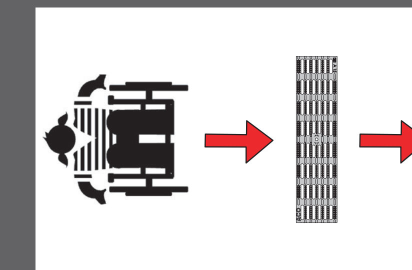
Slip resistance is critical for user safety. Ideally the slip resistance of the grate should be similar to the surrounding pavement to avoid both slip and/or trip hazards.

Selection guidance and test data

ADA REQUIREMENTS are set out in The Americans with Disabilities Act of 1990; Section 4.5.4.

Where grates are used within walking surfaces, the open slots should be no greater than 0.5 inches (12.7mm) wide in one direction. Where the length of the slot is greater than 0.5 inches, the opening should run perpendicular to the main direction of traffic

The diagram shows the slots perpendicular to the flow of traffic; this helps prevent wheelchair wheels and walking aids becoming trapped or slipping on the grate surface.



HEEL RESISTANT - ASME: A112.6.3 : Section 7.12 Heel Resistant Strainers & Grates

*A grate designed to resist entry of heeled shoes, in which the maximum grate hole size in least dimension shall be **0.31" (8mm)**.*

HEEL SAFE

SAFE

For applications where high stilletto heels are commonplace, ACO recommends grates with openings of 0.25" (6.5mm) or less to prevent heels from becoming trapped, causing injury or falls.

BICYCLE SAFE - AS 3996 - 2006 Clause 3.3.6

No US Standard exists detailing slot sizes to avoid bicycle tires from becoming trapped. ACO rates grates based on Australian Standard AS 3996 - 2006 Clause 3.3.6 which specifies maximum slot length dependent on slot width for grates that are deemed *Bicycle Tire Penetration Resistant.*

There are a number of locking options available, including:

BOLTLESS LOCKING - mechanisms that hold grates captive without use of bolts. They are quick to install and remove, making installation and maintenance easier.

BOLT LOCKING - uses bolts to hold grates in place. Bolts fasten into either the frame or locking bar that straddles the trench.

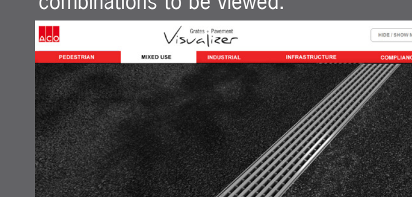
OTHER LOCKINGS - on rare occasions, something other than standard lockings are required, such as tamper resistant bolts. Contact ACO for more information.

Aesthetic options are typically based on:

GRATE MATERIALS - stainless steel, ductile iron and plastic can all offer excellent aesthetics. Monolithic trench drains are manufactured using the same material for the grate and trench drain body.

GRATE SLOT PATTERNS - perforated, slotted, mesh and decorative patterns are available.

To help determine the right aesthetics for a project, ACO offers an online grate *Visualizer* that allows pavement and grate choice combinations to be viewed.



ACO has tested grate patterns using the widely accepted pendulum test.

PENDULUM TEST - A pendulum is swung over a wet surface and measures surface frictional properties. Test results are given a BPN value - typically values in excess of 24 would be used (24 and under is regarded as high slip and skid potential).

ACO recommends selecting a grate with the similiar BPN values as the surrounding pavement finish. Pavement slope, presence of surface contaminants, etc. can also negatively affect slip and skid resistance.

Other tests exist, such as the Variable-angle ramp test and horizontal pull test and can be carried out as necessary if required for specific projects.

Catchment hydraulics - calculating run-off

To calculate correct size of trench drain, catchment run-off must be calculated.

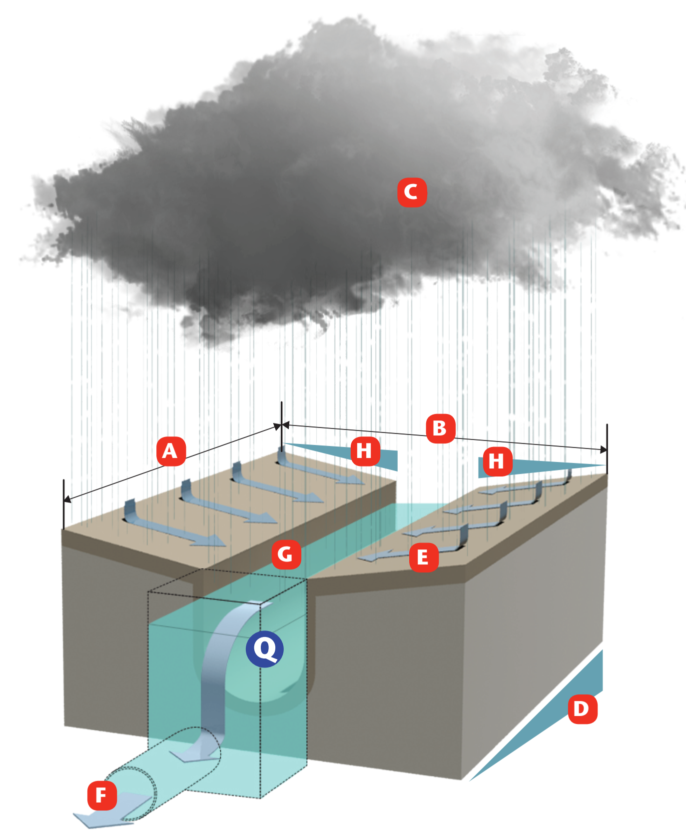
$$Q\ (GPM) = \frac{\text{Area } (A \times B) \times \text{Rainfall intensity } (C)}{60(\text{minutes}) \times 1.6(\text{Conversion to gallons})}$$

- Catchment area = pavement length x width (ft) .... A x B
- Rainfall intensity in inches per hour C

www.ACODrain.us
link to US government rainfall frequency atlas

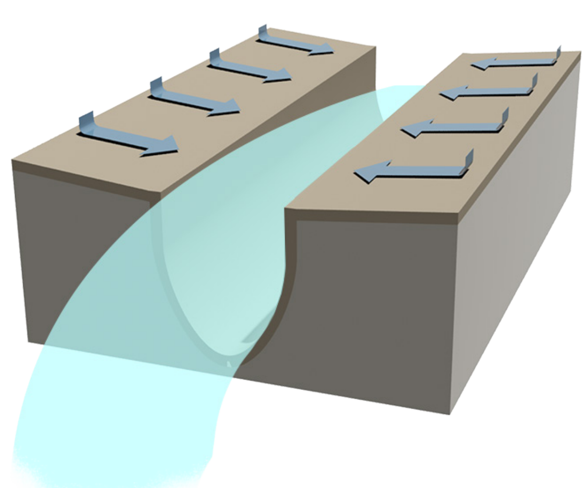
Once catchment run-off Q is calculated, other inflows, e.g. down spouts, can be added. Other factors that affect trench drain hydraulics:

- Ground fall percentage .... D
- Pavement material - some materials absorb liquids, e.g. brick pavers ...... E
- Position and size of outlet pipe ...... F
- Surface roughness of trench material. Manning's coefficient of roughness figures. *See page 137* .... G
- Angle of approach to trench - this can affect grate hydraulics (steep slopes may cause bypass) .... H



Non-uniform flow (Spatially Varied Flow)

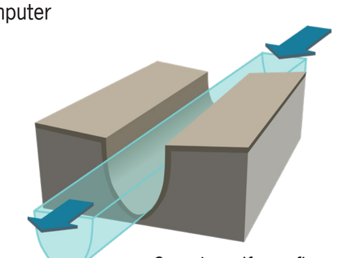
$$\frac{dy}{dx} = \frac{S_0 - S_f - 2\alpha Qq / gA^2}{1 - \alpha Q / gA^2 D}$$



Non-uniform flow accounts for liquid being carried in a trench plus the constant addition of liquid collected through the grates along the trench run - lateral intake. Run lengths, therefore, also influence a trench drains capacity.

A characteristic of non-uniform flow is liquid velocity and height change at successive cross sections along the trench.

To correctly model this situation, differential calculus is required; usually computer modeling is needed.



Steady uniform flow

Hydro is a purpose written, hydraulic design program modeled on differential calculus for non-uniform flow in open channels. *See page 142*. The program has been calibrated by empirical data following a series of experiments modeling lateral intake into trenches. Analysis of the effect of slope, run length, and trench cross sectional profiles are incorporated into the program.

Complex scenarios such as the effects of water inflow from down spouts or inlets along the length of the trench can also be modeled by the Hydro program. ACO can use Hydro to recommend optimum outlet positions along trench runs.

Hydro software - modeling trench hydraulics

To generate results from the Hydro program, the following information is required:

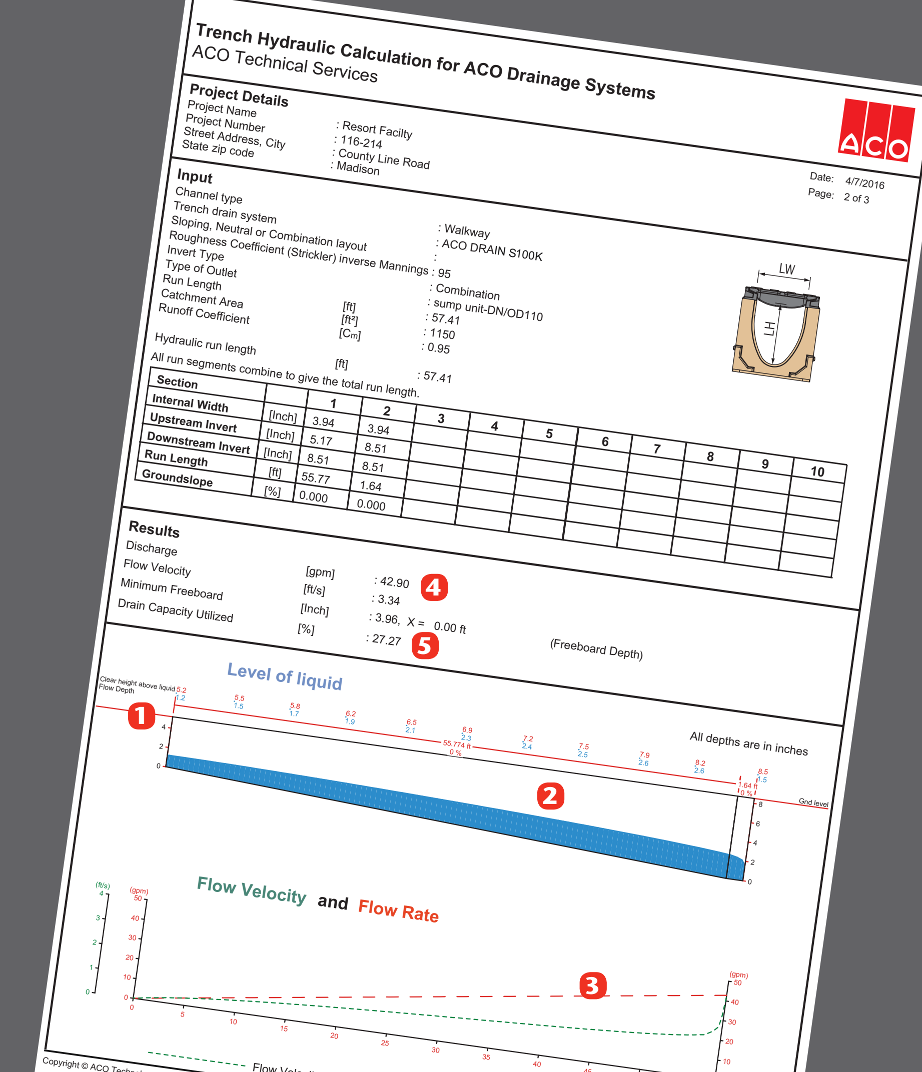
- *Length of trench run (feet or meters)*
- *Length and width of catchment area (feet or meters). See page 142.*
- *Surrounding pavement/surface type, e.g., concrete, asphalt, etc.*
- *Rainfall intensity (in/hr or mm/hr)*
- *Ground fall along trench (%)*
- *Perpendicular approach slopes to trench (%)*
- *Preferred position of outlets along trench and any outlet size restrictions*
- *Any slab depth restrictions*

Results are provided either electronically and/or in printout format, in metric or imperial units.

Electronic request form can be found at **www.ACODrain.us**.

Hydro printout shows:

1. Position and size of minimum freeboard (gap between underside of grate and top of liquid in trench)
2. Hydraulic profile of liquid
3. Flow velocity and flow rate at all points along the trench
4. Maximum discharge capacity of trench run. (42.9 GPM - 2.7 l/s from example below)
5. Hydraulic utilization of trench (%) is given. If over 100%, flooding occurs. (27.27% from example below)



Trench Hydraulic Calculation for ACO Drainage Systems
ACO Technical Services

Date: 4/7/2016
Page: 2 of 3

Project Details
Project Name : Resort Facilty
Project Number : 116-214
Street Address, City : County Line Road
State zip code : Madison

Input
Channel type : Walkway
Trench drain system : ACO DRAIN S100K
Sloping, Neutral or Combination layout :
Roughness Coefficient (Strickler) inverse Mannings : 95
Invert Type : Combination
Type of Outlet : sump unit-DN/OD110
Run Length [ft] : 57.41
Catchment Area [ft²] : 1150
Runoff Coefficient [Cm] : 0.95
Hydraulic run length [ft] : 57.41
All run segments combine to give the total run length.

Section		1	2	3	4	5	6	7	8	9	10
Internal Width	[Inch]	3.94	3.94								
Upstream Invert	[Inch]	5.17	8.51								
Downstream Invert	[Inch]	8.51	8.51								
Run Length	[ft]	55.77	1.64								
Groundslope	[%]	0.000	0.000								

Results
Discharge [gpm] : 42.90
Flow Velocity [ft/s] : 3.34
Minimum Freeboard [Inch] : 3.96, X = 0.00 ft (Freeboard Depth)
Drain Capacity Utilized [%] : 27.27

Level of liquid
All depths are in inches

Flow Velocity and Flow Rate

Copyright © ACO Techn...

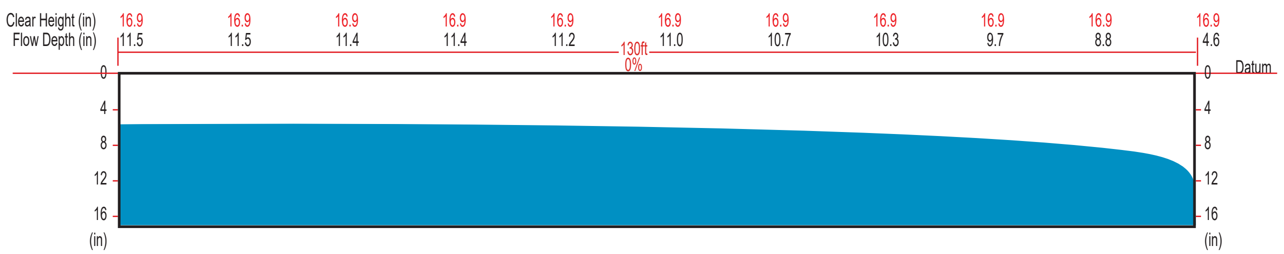
Ponding analysis - trench hydraulics

Effect of slope on trench hydraulic performance

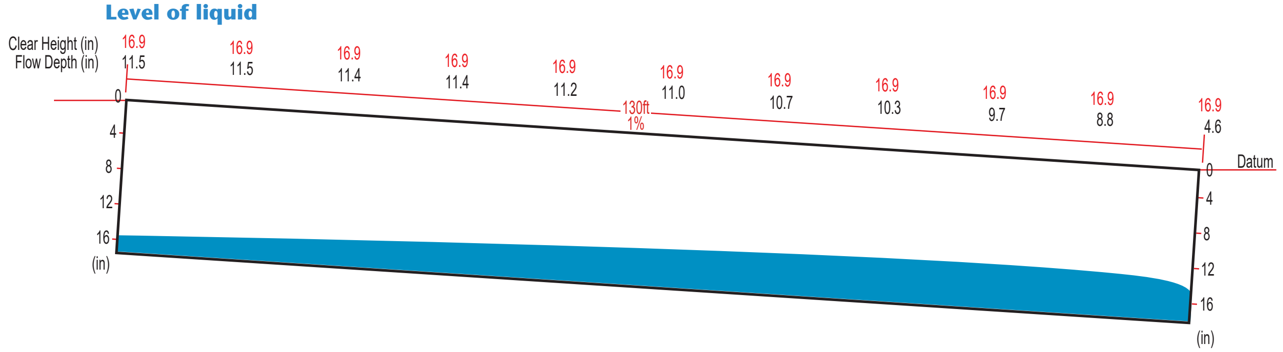
Slope increases the hydraulic performance of the trench system because flow velocity is increased. The drawings below highlight the water profile in the trench - all parameters are the same on both examples except lower image has a 1% slope added.

This increase in capacity may result in larger areas being drained, outlets spaced further apart, or a narrower or shallower trench system being specified which will result in product and/or installation savings.

Level of liquid



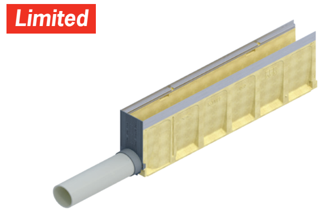
Level of liquid



Size and type of outlet

In modeling hydraulic performance of trench drains, the assumption is that the outlet is not a restricting factor. Designers should ensure outlet, and subsequent pipe infrastructure, is not undersized and restricts outflow of the trench drain.

Limited

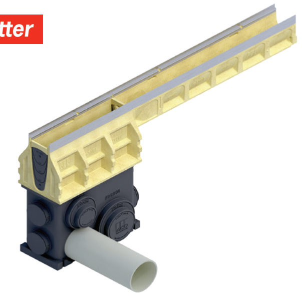


End outlet - pipe connected horizontally at the end of the trench. Minimizes excavation but offers lowest outlet capacity.

Good

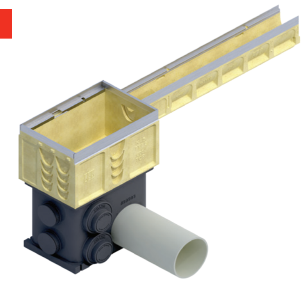
Bottom outlet - pipe connected vertically out of the bottom of the trench. Offers improved outlet capacity due to gravity.

Better



In-line catch basin - same width as trench, but deeper. Offers superior outlet capacity as large pipes can be connected and increased depth gives significant head of water pressure.

Best

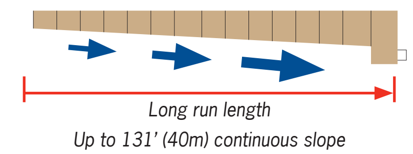


Catch basin - large basin wider and deeper than trench. Offers best outlet capacity as larger pipes can be used and increased depth gives significant head of water pressure.

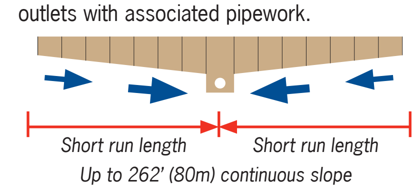
Position of outlet

A trench drain is ultimately connected to an underground pipe system. Outlet position can dramatically affect size and length of trench drain required.

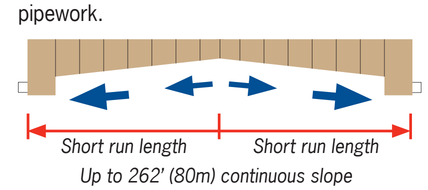
End outlet - Water builds up along trench and may flood before reaching outlet. A larger/more costly trench drain and/or more outlets may be required.



Central outlet - If zero ground slope, run lengths to outlet are shorter and less likely to exceed capacity and flood. Allows smaller, more economic trench drain and/or fewer outlets with associated pipework.



Double end outlet - Where zero ground slope, allows run lengths to outlet to be shorter and less likely to exceed capacity and flood. Allows smaller, more economic trench drain but more outlets and associated pipework.

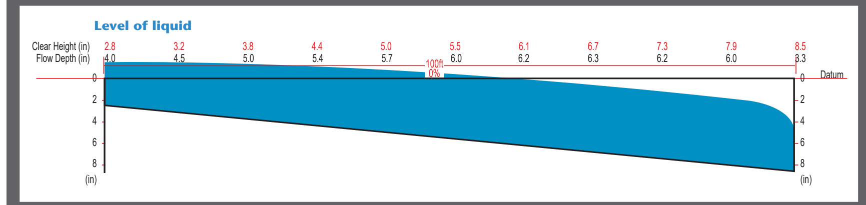


Temporary ponding is a short lived flood situation, which, in some circumstances, can be tolerated with an intentionally undersized trench drain. It allows a more economical system to be used that will work effectively under average weather conditions, but will be slightly under designed for heavy storms.

Ponding analysis should only be considered where buildings and property are not in close proximity to the drainage system to minimize risk of damage. It is an ideal option for the outer areas of large parking lots, distribution yards, etc. (Risk Analysis should be carried out). The ponding analysis map shows the size and duration of the flood.

In order to produce a ponding analysis, the following information is required:

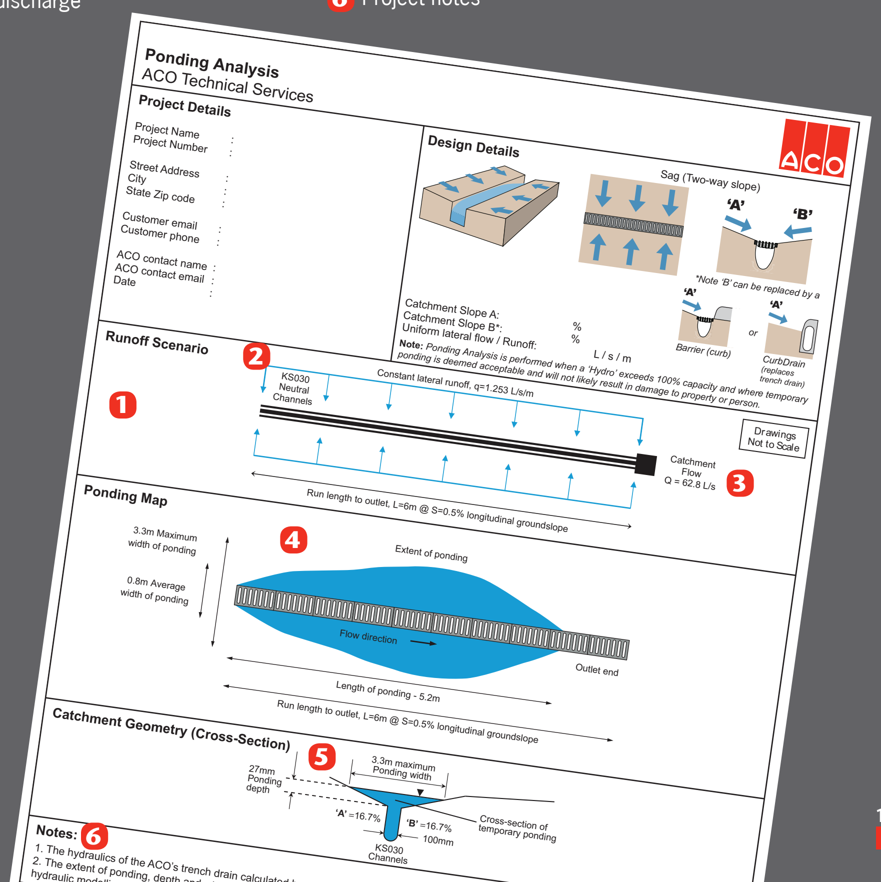
- *Full information required to run the Hydro printout.* *See page 143.*
- *Plan of site showing elevations*
- *Existence of any buildings*



Flooded Hydro printout indicates that ponding will occur and either a Ponding Analysis should be done or channel metrics (width, depth, run length) re-evaluated.

Ponding analysis shows:

1. Run-off scenario
2. Trench drain length, size and type
3. Design discharge
4. Visual map of worst ponding scenario
5. Width of temporary ponding
6. Project notes



Grate hydraulics

Usually the trench drain reaches hydraulic capacity before the grate. However, where there are concentrated flows running down steep slopes, the grate may not be capable of capturing all flow - even if the underlying trench is correctly sized.

Properly located trench runs put grates in the direct path of surface water runoff, exposing them to the following conditions:

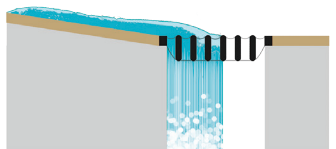
- Flow rate of liquid from catchment area or point source(s). See page 142.
- Velocity and approach head (depth) of liquid determined by catchment roughness and slope.

A grate has a finite capacity to capture flow (surface water run-off) originating from catchment area - bypass occurs when the grate's hydraulic capacity is exceeded.

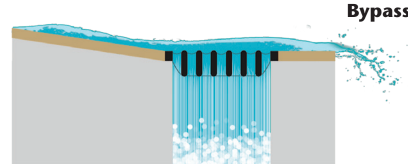
A grate's hydraulic performance is influenced by:

1. **Grate characteristics**
   - Intake area
   - Width of grate
   - Design features e.g. direction of bars/slots, slip resistant features
2. **Catchment characteristics**
   - Approach catchment slope (determines water velocity)
   - Catchment roughness (determines flow direction, water velocity and head)
   - One direction (barrier drain) or two or more directions (sag/valley drain)
   - Type of liquid
   - Debris

Designers should be aware of the trade-off between small inlets for heel safety and large inlets for optimum grate hydraulics.



100% Capture
All liquid flowing through grate openings.



Less than 100% Capture
Not all liquid flows through grate openings - bypass occurs. Reasons:

- Not enough grate open area.
- Too much liquid.
- Too much slope perpendicular to grate.

The science of grate hydraulics is difficult to model in fluid mechanics. A grate's hydraulic performance can be greatly influenced by subtle changes to grate, and/or catchment characteristics described left.

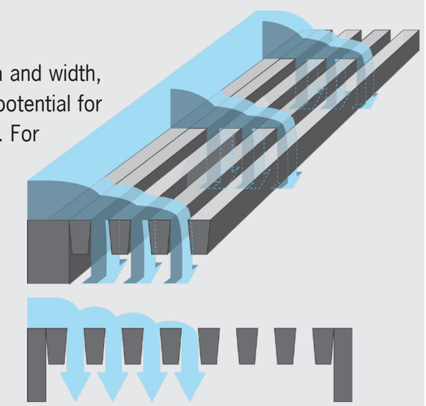
When liquid moves over a grate, either/or a combination of two scenarios can occur:

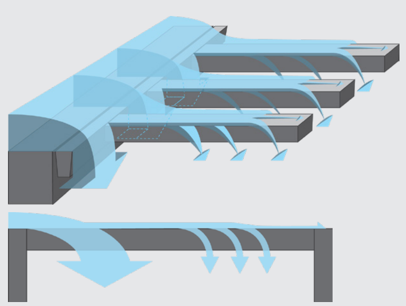
- **Weir scenario**: relevant where water depths are minimal and approach with speed.
- **Drowned orifice:** relevant where there is an accumulation of water above grate.

Drains positioned in sag/valley locations give rise to higher flow rates due to pressure of substantial static head (liquid depth) being pushed through grate openings.

Longitudinal opening grate at capacity
When comparing grates of equal intake area and width, longitudinal opening grates offer maximum potential for flow evacuation leading to high water intake. For example:

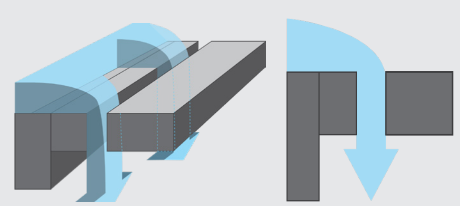
- 4 bars to interrupt and slow down flow before weir is produced.
- Slots 1, 2, 3 are treated as drowned orifices.
- Slot 4 acts as a weir.





Transverse opening grate at capacity
When comparing grates of equal intake area and width, transverse grates offer moderate water intake. Bars bridge across both sides of trench giving little flow interruption, but some drowned orifice effect.

Slot opening grate at capacity
There is very little flow interruption before the weir is produced leading to low water intake. The minimal depth above the slot will have negligable drowned orifice effect.



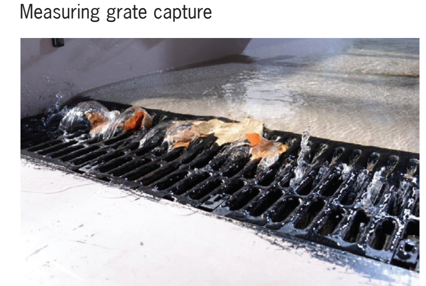
Grate intake experiments

Due to the complex nature of fluids in relation to grate inlet hydraulics, testing is the only way to accurately predict how a grate will intercept surface water run-off.

ACO has contracted leading universities for the purpose of research and testing, in the area of grate hydraulics. Three studies carried out in 2016, 2004 and 1998 show capture rates for a number of ACO grates recorded at various water flows discharging down a ramp at a set of longitudinal angles, and cross falls.

Based on project specific requirements, results from these empirical tests allow ACO to accurately recommend a grate for designers with specific catchment hydraulics.

Measuring grate capture



Leaves and other debris can impact hydraulic performance and can be incorporated into ACO's software.

Grate hydraulics - GIC service

ACO has independently measured, by experimentation, the hydraulic intake capacities of ACO grates. Tests were carried out under varying flow rates and catchment approach slopes. To determine the hydraulic utilization, each grate was tested until bypass occurred (point at which liquids would pass across grate).

ACO's Grating Intake Calculator (GIC) provides information on intake efficiency of chosen grate. If liquid intake is greater than grate's capacity, extent of bypass (or failure) will be calculated.

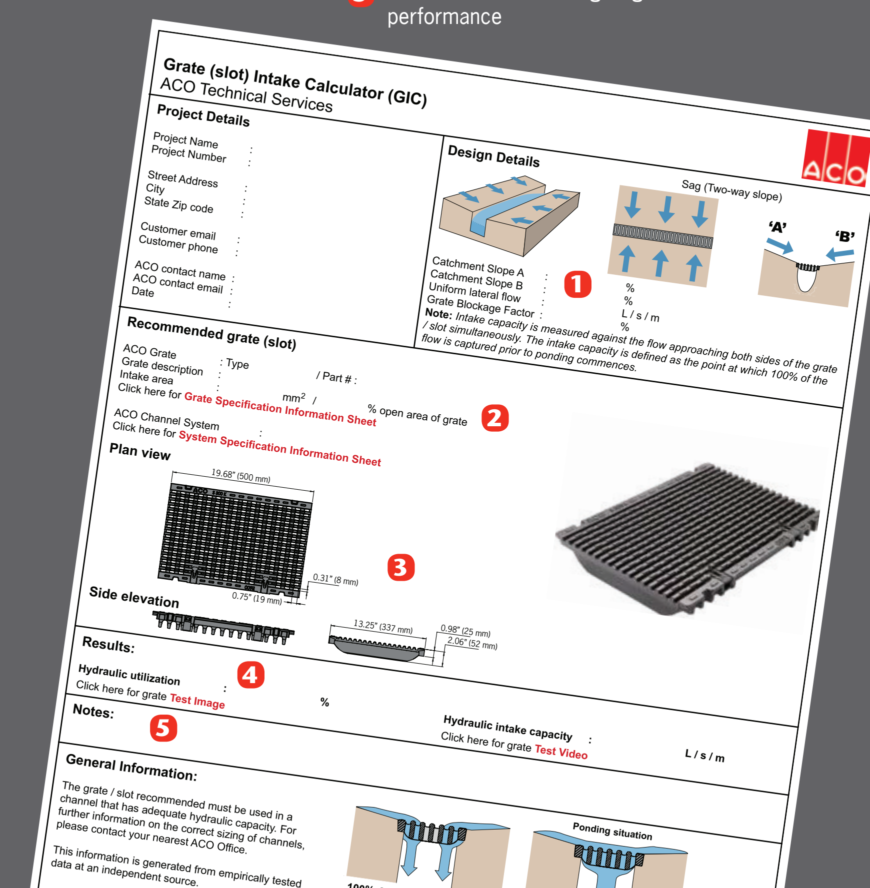
To generate results from the GIC program the following information is required:

- *Length of trench run (feet or meters)*
- *Length and width of catchment area (feet or meters). See page 142.*
- *Position of trench in catchment area*
- *Surrounding pavement/surface type, e.g., concrete, asphalt, etc.*
- *Rainfall intensity (in/hr or mm/hr)*
- *Perpendicular approach slopes to trench (%)*
- *Preferred grate type*

Results are provided either electronically and/or in printout format.

GIC printout shows:

1. Catchment geometry and hydraulics
2. Total intake area per foot of trench run
3. Recommended grate information
4. Hydraulic utilization of grate (100% means all grate intake capacity is used)
5. Additional notes relating to grate performance


Grate (slot) Intake Calculator (GIC)
ACO Technical Services

Project Details
Project Name :
Project Number :
Street Address :
City :
State Zip code :
Customer email :
Customer phone :
ACO contact name :
ACO contact email :
Date :

Design Details
Sag (Two-way slope)
'A' 'B'
Catchment Slope A : %
Catchment Slope B : %
Uniform lateral flow : L / s / m
Grate Blockage Factor : %
1
Note: *Intake capacity is measured against the flow approaching both sides of the grate / slot simultaneously. The intake capacity is defined as the point at which 100% of the flow is captured prior to ponding commences.*

Recommended grate (slot)
ACO Grate : Type / Part # :
Grate description :
Intake area : mm² / % open area of grate
Click here for Grate Specification Information Sheet
2
ACO Channel System :
Click here for System Specification Information Sheet
Plan view
19.68" (500 mm)
0.31" (8 mm)
0.75" (19 mm)
3
Side elevation
13.25" (337 mm)
0.98" (25 mm)
2.06" (52 mm)

Results:
Hydraulic utilization : %
4
Click here for grate Test Image
Hydraulic intake capacity : L / s / m
Click here for grate Test Video

Notes:
5

General Information:
The grate / slot recommended must be used in a channel that has adequate hydraulic capacity. For further information on the correct sizing of channels, please contact your nearest ACO Office.

This information is generated from empirically tested data at an independent source.
Ponding situation

Run layout service and part scheduling

ACO Scheduler

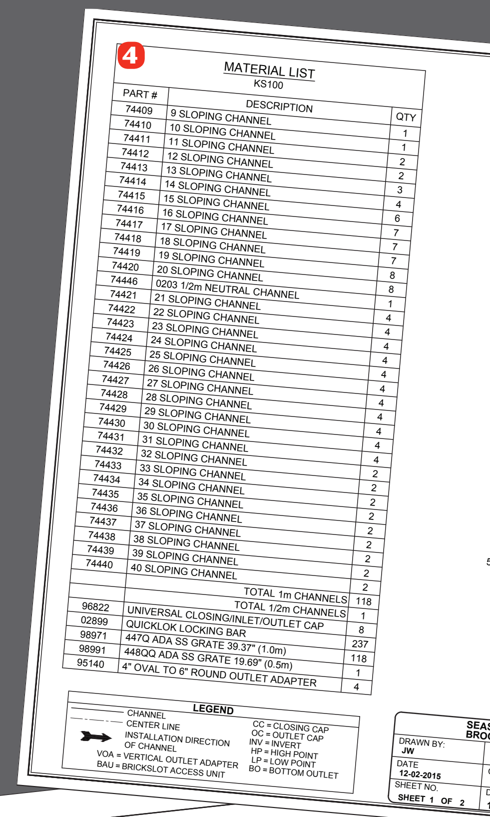
ACO has written a proprietary software program, Scheduler, that shows trench drain runs in profile and plan views. The program automatically prints out each run showing positions of accessories, outlets, junctions, etc. It automatically calculates a Bill of Materials for each run and totals multiple runs to ensure the correct amount of parts and pieces are ordered. Scheduler printouts are particularly useful for installers.

Results provided are:

- *Sectioned profile of trench runs*
- *Plan view of trench runs*
- *Parts schedule fully itemizing parts and pieces*

Scheduler printouts provide:

1. Profile and plan view of each trench run
2. Trench run direction change - e.g. 90° corner or junction
3. Positions and type of outlets
4. Detailed Bill of Materials to ensure all parts are correctly ordered



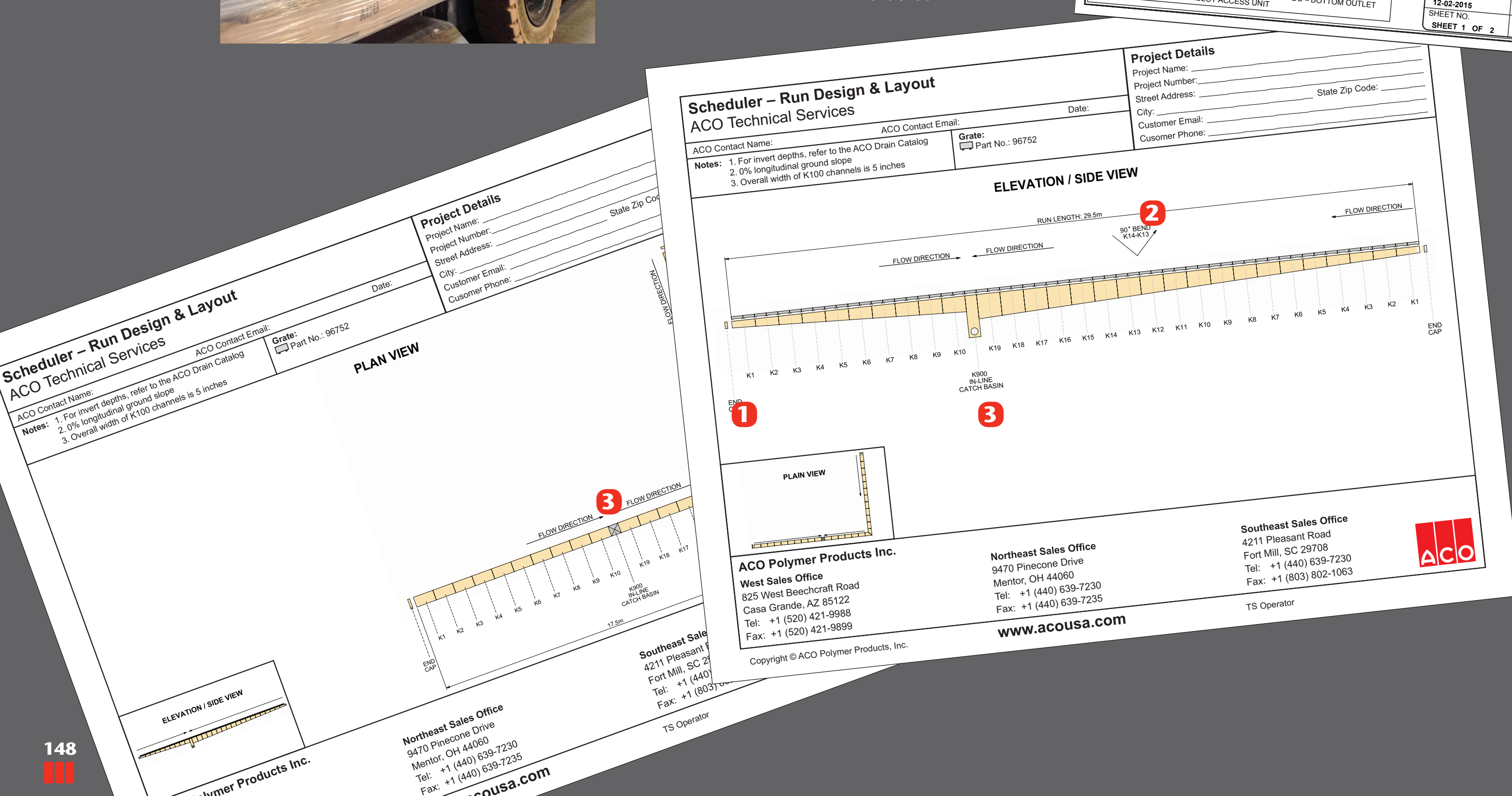
4

MATERIAL LIST
KS100

PART #	DESCRIPTION	QTY
74409	9 SLOPING CHANNEL	1
74410	10 SLOPING CHANNEL	1
74411	11 SLOPING CHANNEL	2
74412	12 SLOPING CHANNEL	2
74413	13 SLOPING CHANNEL	3
74414	14 SLOPING CHANNEL	4
74415	15 SLOPING CHANNEL	6
74416	16 SLOPING CHANNEL	7
74417	17 SLOPING CHANNEL	7
74418	18 SLOPING CHANNEL	7
74419	19 SLOPING CHANNEL	8
74420	20 SLOPING CHANNEL	8
74446	0203 1/2m NEUTRAL CHANNEL	1
74421	21 SLOPING CHANNEL	4
74422	22 SLOPING CHANNEL	4
74423	23 SLOPING CHANNEL	4
74424	24 SLOPING CHANNEL	4
74425	25 SLOPING CHANNEL	4
74426	26 SLOPING CHANNEL	4
74427	27 SLOPING CHANNEL	4
74428	28 SLOPING CHANNEL	4
74429	29 SLOPING CHANNEL	4
74430	30 SLOPING CHANNEL	4
74431	31 SLOPING CHANNEL	4
74432	32 SLOPING CHANNEL	2
74433	33 SLOPING CHANNEL	2
74434	34 SLOPING CHANNEL	2
74435	35 SLOPING CHANNEL	2
74436	36 SLOPING CHANNEL	2
74437	37 SLOPING CHANNEL	2
74438	38 SLOPING CHANNEL	2
74439	39 SLOPING CHANNEL	2
74440	40 SLOPING CHANNEL	2
	TOTAL 1m CHANNELS	118
	TOTAL 1/2m CHANNELS	1
96822	UNIVERSAL CLOSING/INLET/OUTLET CAP	8
02899	QUICKLOK LOCKING BAR	237
98971	447Q ADA SS GRATE 39.37" (1.0m)	118
98991	448QQ ADA SS GRATE 19.69" (0.5m)	1
95140	4" OVAL TO 6" ROUND OUTLET ADAPTER	4

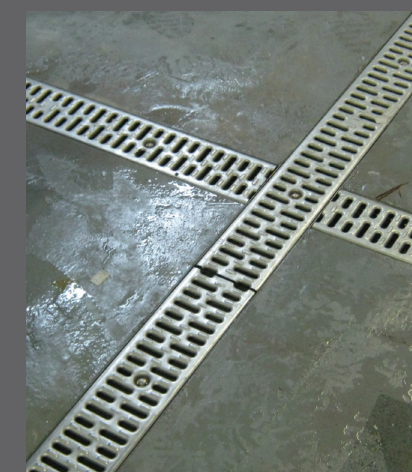
LEGEND
CHANNEL
CENTER LINE
INSTALLATION DIRECTION OF CHANNEL
VOA = VERTICAL OUTLET ADAPTER
BAU = BRICKSLOT ACCESS UNIT
CC = CLOSING CAP
OC = OUTLET CAP
INV = INVERT
HP = HIGH POINT
LP = LOW POINT
BO = BOTTOM OUTLET

DRAWN BY: JW
DATE 12-02-2015
SHEET NO. SHEET 1 OF 2



CAD design services

For more complex projects ACO can provide a custom trench drain layout using Auto-CAD to illustrate required positions and layouts of trench runs.



In order to produce a plan layout, the following information is required:

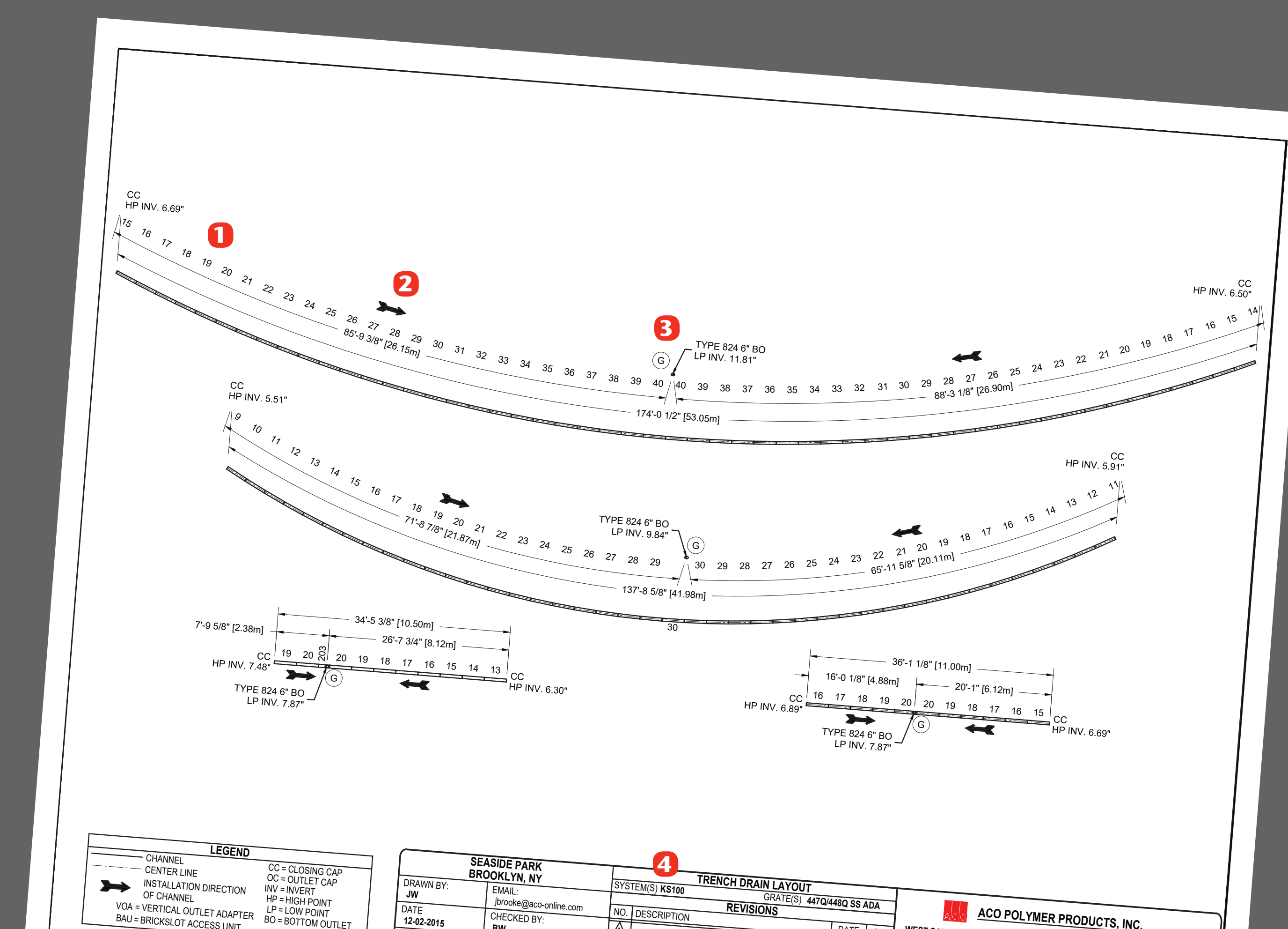
- *Plan of site showing elevations*
- *Existence of any depth restrictions*
- *Position and type of any plumbing fixtures/outlets*
- *Position of any permanent structures*
- *Liquid flow pattern and type of traffic (including traffic flow)*

Results provided are:

- *Plan layouts (CAD) showing the trench drain positions relative to site structures*

CAD printout provides:

1. Plan view of trench run layout with inverts
2. Liquid flow directions
3. Position and type of outlet
4. Trench and grate type



train design support care

Installation guidelines

ACO has a qualified site support technician available for installation training and assistance.

A fabrication service can assist with creating difficult corners, tees, shortened channels, etc. to make installation quicker and easier.

A Site Installation Guide is available, in addition to installation section drawings.

Installation

Channel units are installed in a continuous trench, and are encased with concrete.

Full installation instructions are available in the Site Installation Manual. Contact ACO or visit ***www.ACODrain.us*** or view ACO Installation videos on ***www.youtube.com/user/acoamerica***

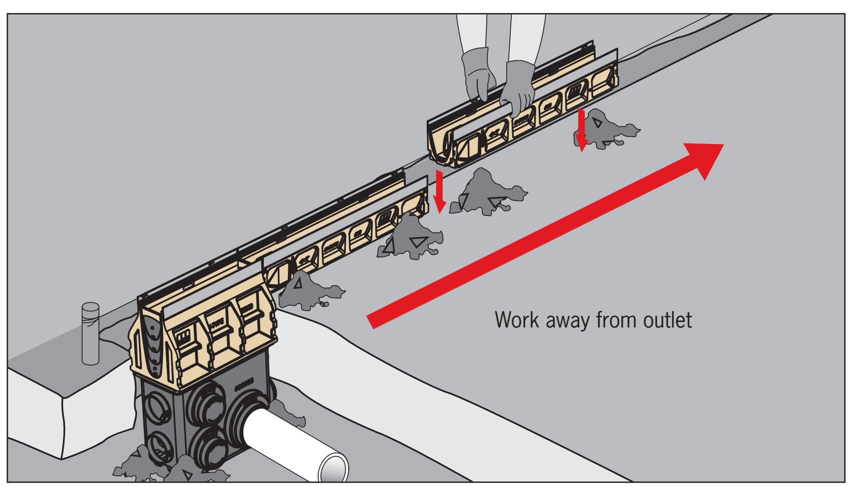
1. Excavation

Excavate trench to accommodate trench drain system. Excavation should be around center line of trench.

Excavation must be sufficient enough to accommodate each of the following:

- Channel/catch basin width and depth dimensions.
- Concrete surround dimensions - 4" - 12". Specific loading and ground conditions will increase the excavation size. *See page 156 for further guidelines.*
- For sloped systems, excavate base to roughly follow fall of trench drain run.

2. Outlet installation



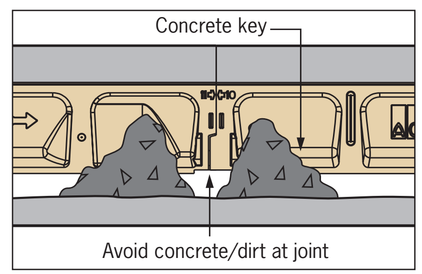
All installations should start from outlet point.

- Determine type of outlet and position
- Install outlet channel/catch basin and set haunch
- Install channels starting at, and working away from, outlet - from deepest (highest channel number) to shallowest

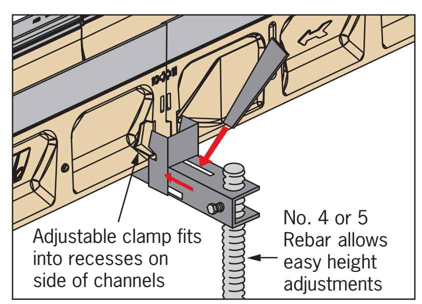
3. Trench drain installation

Channel units need to be supported at correct height and held securely in place to avoid movement during concrete pour. There are a number of options available:

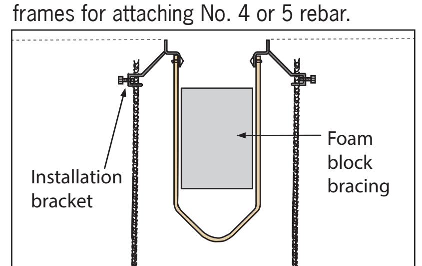
Patty supports
Care should be taken that concrete is not trapped in joint between channels.



Installation device
A clamping system that fits around the profiled end. Rebar is used to achieve correct height. One device per joint is required. 100, 200 & 300mm wide versions available.

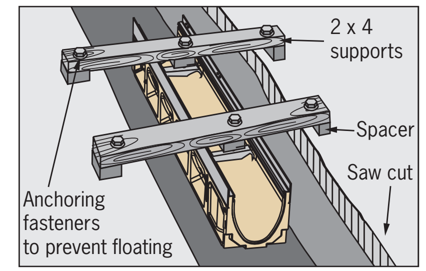


FG200 has installation devices attached to frames for attaching No. 4 or 5 rebar.



Note: foam block bracing to prevent channel deforming during concrete pour.

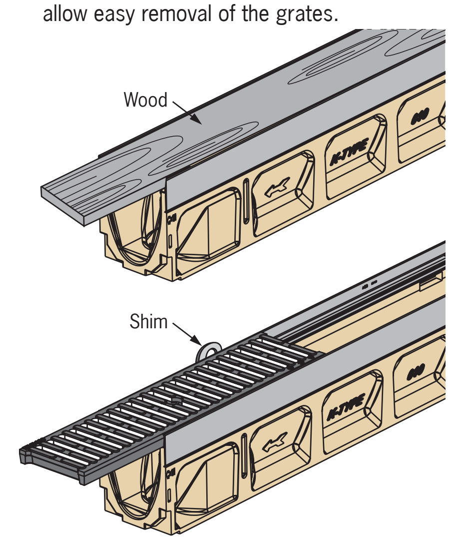
Hanging method
Channels can also be hung from grate locking. Useful in retrofit where existing slab is used to support channels.



4. Channel bracing

To prevent channel walls and joints being distorted by pressure of concrete, grates (or plywood cut to a snug fit) should be installed in channel prior to concrete pour.

Shims or washers placed along each side allow easy removal of the grates.



5. Concrete pour

Concrete should have compressive strength of minimum 4,000 psi.

Grates should be suitably wrapped to protect from concrete splash.

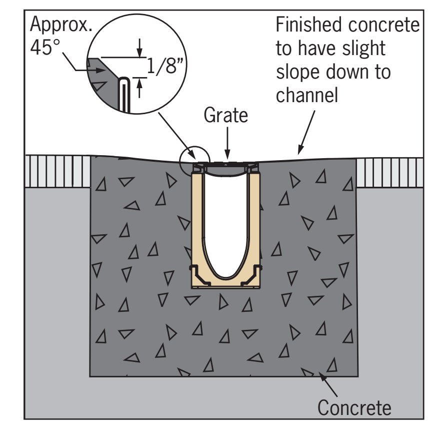
Concrete should be poured evenly (both sides of channel) and carefully to avoid dislodging channels. A wand-type vibrator should be used to ensure concrete distributes evenly underneath and around channels.

6. Pavement finishing

Top of adjacent pavement must be above grate level by approximately 1/8" (3mm).

Brick pavers should be set approx. 1/8" (3mm) above trench edge. First brick course should be set on mortar/concrete.

Care should be taken with asphalt rolling machines to avoid damage to trench edge.



7. Completing installation

- Remove grates and remove protective wrapping.
- Remove debris from trench drain and make sure outlet pipes are clear.
- Install trash buckets in catch basins, if required.
- Flush trench run to check for pipe work blockages; unblock if necessary.
- Empty trash buckets and clean out pipe connections, if necessary. Re-install trash buckets.
- Re-install grates in proper position ensuring they are securely locked down.

The trench drain is now ready for use.

Maintenance

Regular inspections of the trench drain are recommended. Frequency will depend on local conditions and environment, but should be done at least annually.

Inspections should cover:

- Grates and locking devices
- Catch basins and trash buckets
- Concrete surround and adjacent paving

All items should be inspected for damage, blockage or movement. Compare with site drawings if necessary.

Maintenance guidelines:

1. Remove grates
2. Remove debris from channel
3. Flush channels with water or high pressure washer (do not use boiling water or aggressive cleaning agents)
4. Repair damaged surfaces where necessary with an appropriate ACO repair kit. *See page 154*.
5. Renew joint seals as required
6. Empty trash buckets and clean out pipe connections
7. Re-install trash bucket
8. Re-install grates, ensuring they are locked back in place

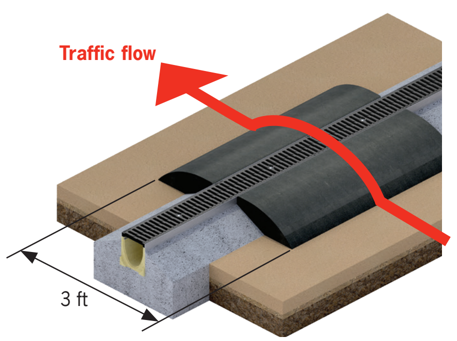
Site work

ACO provides separate installation details for each product with comprehensive on-site advice, when appropriate.

Ground conditions

Specific ground conditions or contaminated ground may call for a deeper/wider concrete surround or larger haunch than minimum recommendations.

If in doubt, seek engineering advice.



Temporary installation

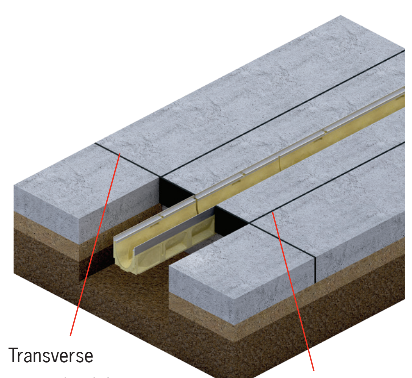
During site work, and after trench run is laid, the trench top can be vulnerable to damage. Site traffic should be routed away from the trench. If temporary crossings are required, a base course of minimum width 3 feet should be installed either side of the trench for protection. Loose boards or plates are inadequate.

Thermal movement

Longitudinal expansion joints, which for some slabs may be doweled horizontally and de-bonded, will isolate the trench and concrete haunch from thermal movement of large concrete slabs.

Transverse joints in the concrete slab should be positioned to coincide with channel-to-channel joints. Alternatively the channel may be cut to align with the slab joint and resealed with a suitable flexible sealant.

Engineering advice should be sought for specifying expansion joints.



Joint sealing

All channel-to-channel and channel-to-fitting joints should be sealed with appropriate sealant.

ACO channels are supplied with an 'SF Sealant Groove' as standard. This provides a groove that can be filled with an appropriate flexible sealant to create a watertight joint. This is particularly important with elevated slabs and where liquids may contain chemicals or oils.

Sealant should be resistant to the same chemicals as the trench material and be flexible to allow for any slab movement from temperature changes. Surfaces should be correctly prepared prior to applying sealant to ensure good adhesion.

Contact ACO Technical Department, or go to www.ACODrain.us for Technical Bulletin.

Sealant applied with caulk gun

Site work accessories

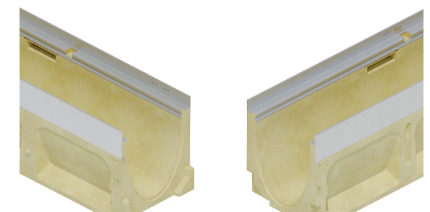
	Part No.	Weight lbs
Seal and patch materials		
ACO Seal flexible joint sealant - 10oz	**91120**	1.0
ACO Bond - polymer concrete repair kit - 1 gallon	**06519**	11.0
ACO Bond - polymer concrete repair kit - 5 gallons	**06516**	55.0
ACO Fiberglass repair kit - 1 gallon	**08203**	11.0

Connection options

Arrows depict direction of slope and flow

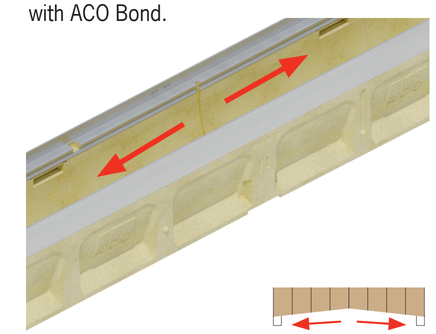
Male-female connection

Interconnecting end details allow easy and effective joining of channels. It also helps with height and sideways alignment between channels. An SF groove provides positive placement for appropriate sealant.



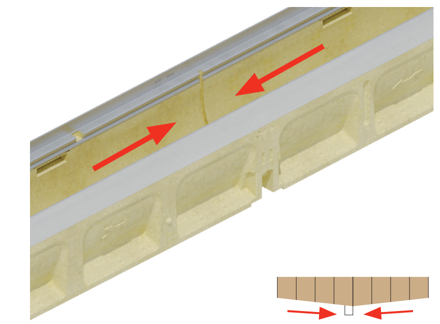
Female-female connection

Creation of a direction change and high point, requires an outlet at start and end of run. To create, remove female end details and butt channels together, hold in place with ACO Bond.



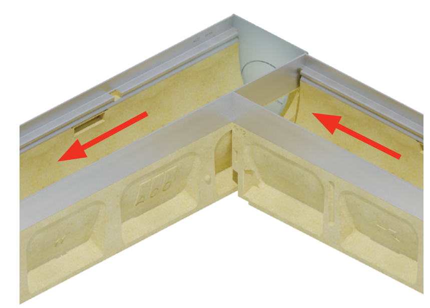
Male-male connection

Creation of a low point, usually with bottom outlet where a catch basin is not required. To create, butt male ends together and fill gaps with ACO Bond.



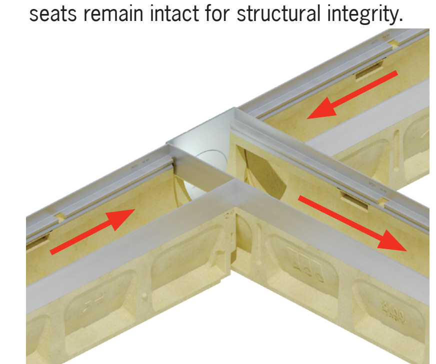
Corner

Corners can be created by butting up as shown below or both channels mitered at 45°.



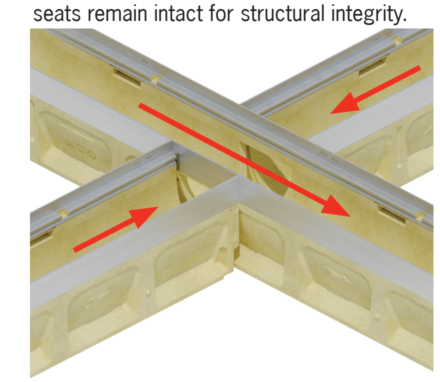
Tee junction

Junction details on sides of constant depth channels allow on-site creation of tees without fabrications. Edge rails and grate seats remain intact for structural integrity.



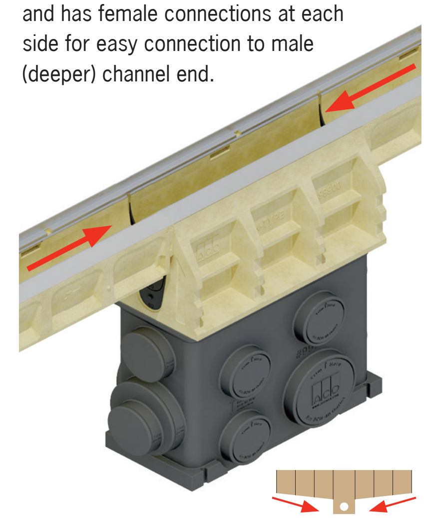
X - cross

Junction details on sides of constant depth channels allow on-site creation of x - cross without fabrications. Edge rails and grate seats remain intact for structural integrity.



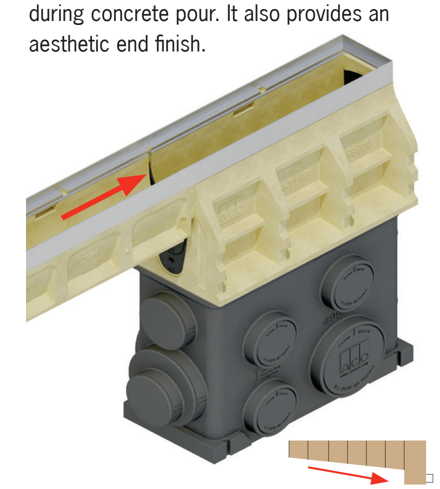
Catch basins

The catch basin is typically the low point and has female connections at each side for easy connection to male (deeper) channel end.



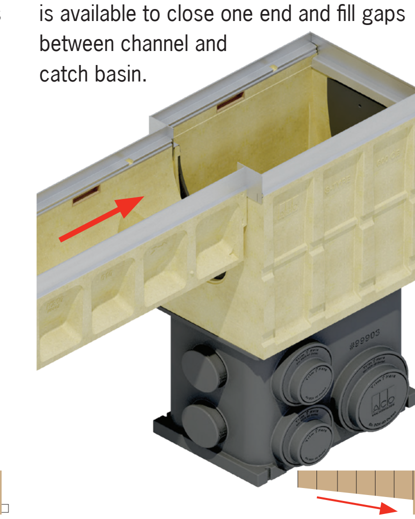
Blanking end plates

For 100mm in-line basins a blanking end plate is supplied to prevent concrete ingress during concrete pour. It also provides an aesthetic end finish.



Blanking end plates

For 200 and 300mm catch basins, a kit is available to close one end and fill gaps between channel and catch basin.



Installation sections

An installed ACO Drain System should incorporate the following:

- Correct grate type
- Correct channel type and size
- Minimum grade 4,000 psi compressive strength cement concrete surround

It is recommended that the cement concrete surround be durable and conform to minimum strength requirements, as shown in the illustrations. Poor site conditions and low load bearing pavements will require an increase in these dimensions to meet both vertical and lateral loads.

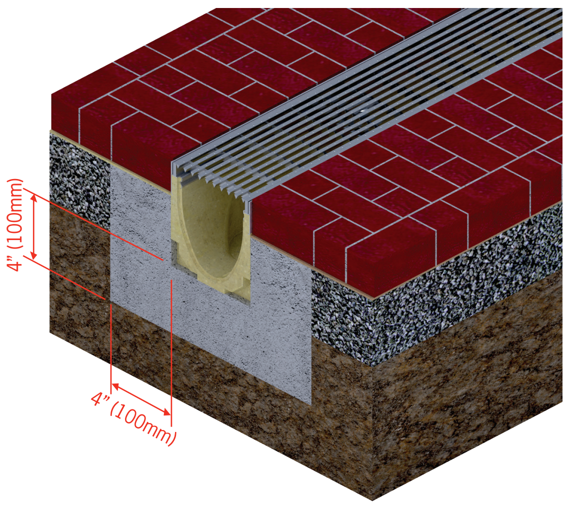
These illustrations are a guide for average ground conditions only. Electronic installation drawings are available at ***www.ACODrain.us***.

It is the customer's responsibility to ensure that encasement size and detail is suitable for the specific application.

These illustrations are typical only.

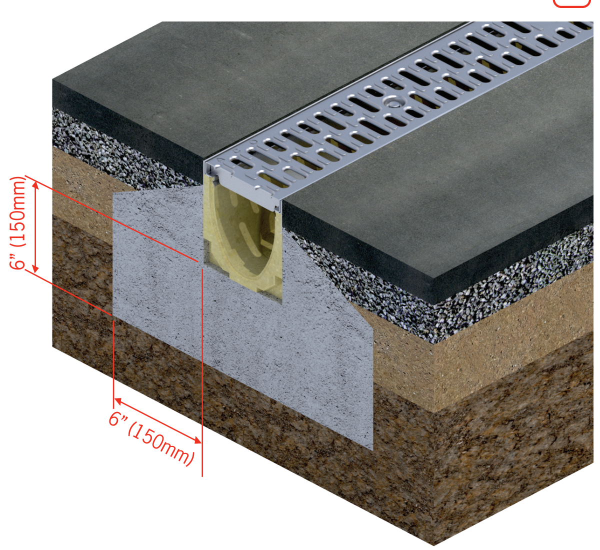
If in doubt, seek engineering advice.

4 in. (100mm) Channels
BLOCK PAVERS - EN 1433 Class B



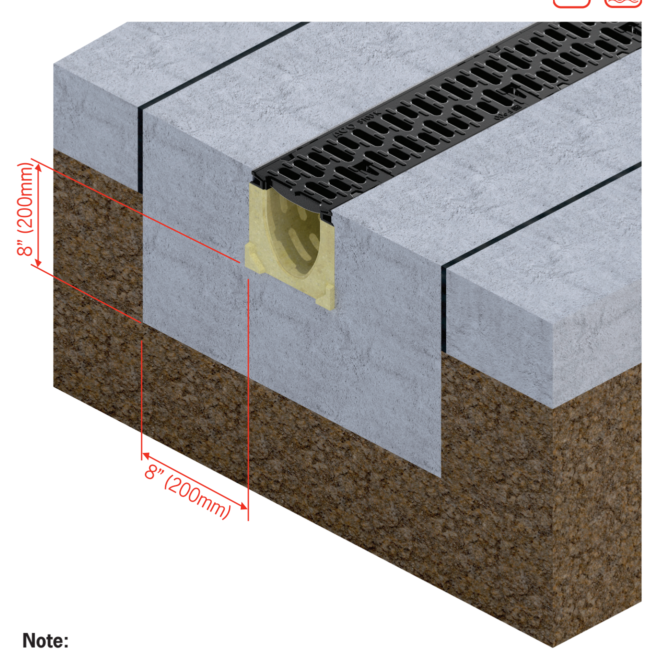
Note:
1. Grate should be 1/8" (3mm) below pavement surface.

4 in. (100mm) Channels
ASPHALT - EN 1433 Class C



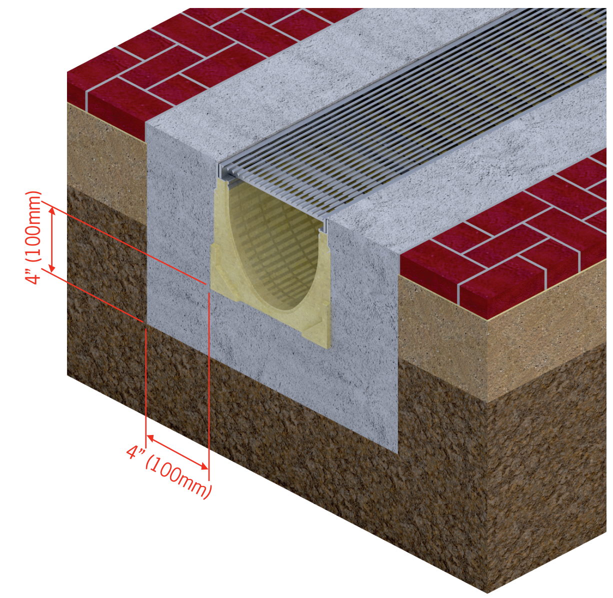
Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Care should be taken with asphalt rolling machines to avoid damage to channel edge and/or grate.

4 in. (100mm) Channels
CONCRETE - EN 1433 Class E/F



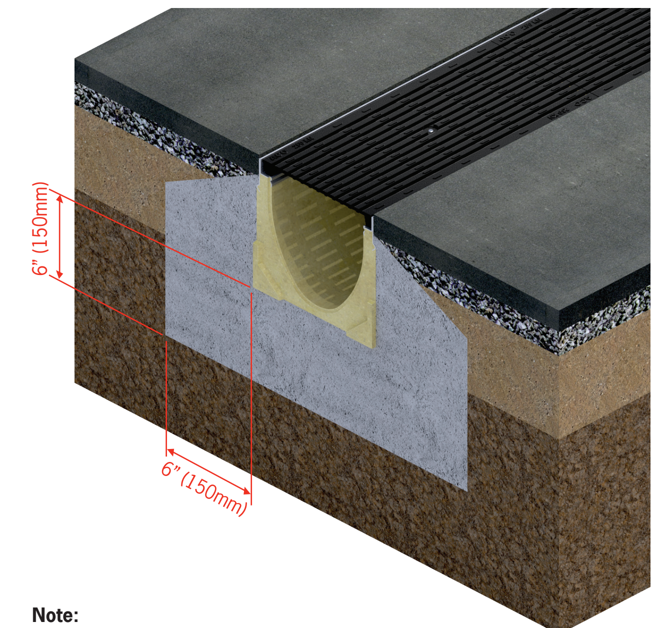
Note:
1. Grate should be 1/8" (3mm) below pavement surface.

8 in. (200mm) Channels
BLOCK PAVERS - EN 1433 Class B



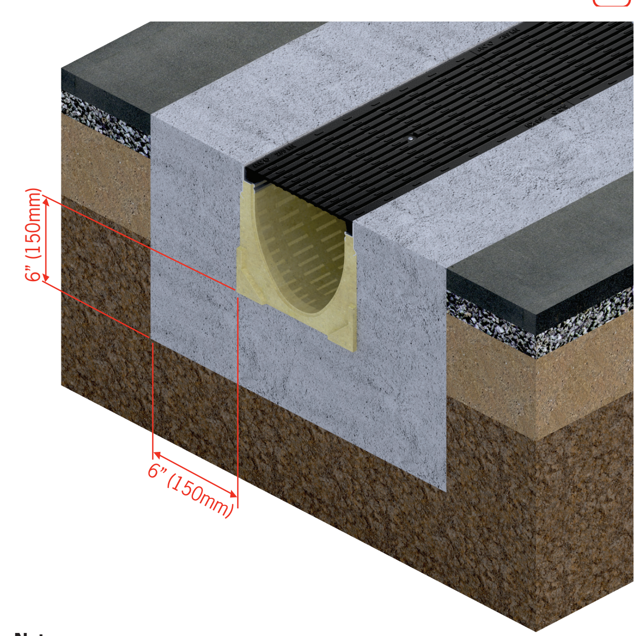
Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Installation brackets on FG200 require a minimum 10" (250mm) surround.

8 in. (200mm) Channels
ASPHALT - EN 1433 Class C



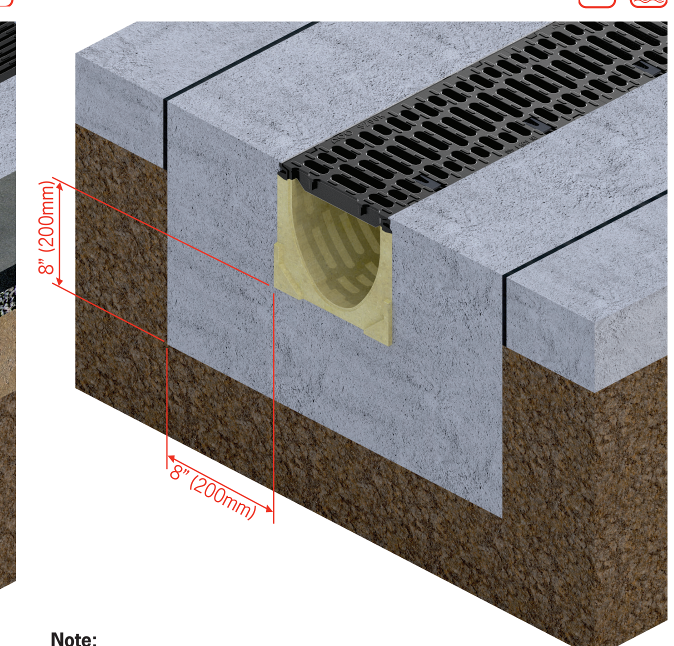
Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Installation brackets on FG200 require a minimum 10" (250mm) surround.
3. Care should be taken with asphalt rolling machines to avoid damage to channel edge and/or grate.

8 in. (200mm) Channels
ASPHALT - EN 1433 Class C



Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Installation brackets on FG200 require a minimum 10" (250mm) surround.

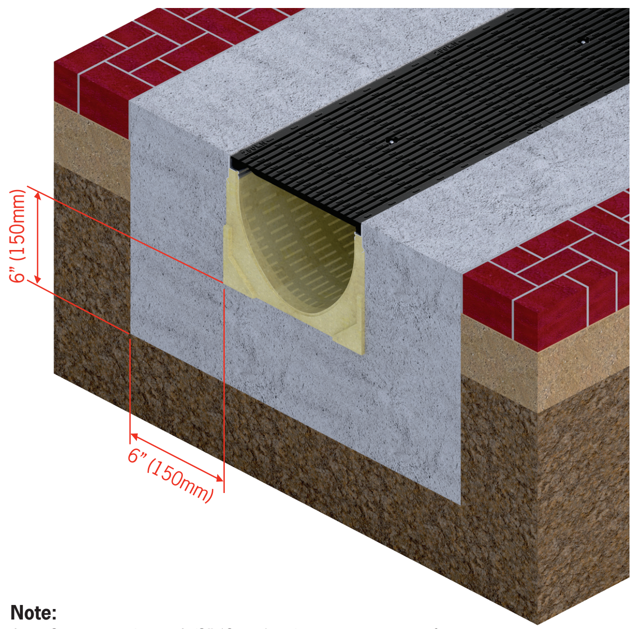
8 in. (200mm) Channels
CONCRETE - EN 1433 Class E/F



Note:
1. Grate should be 1/8" (3mm) below pavement surface.
2. Installation brackets on FG200 require a minimum 10" (250mm) surround.

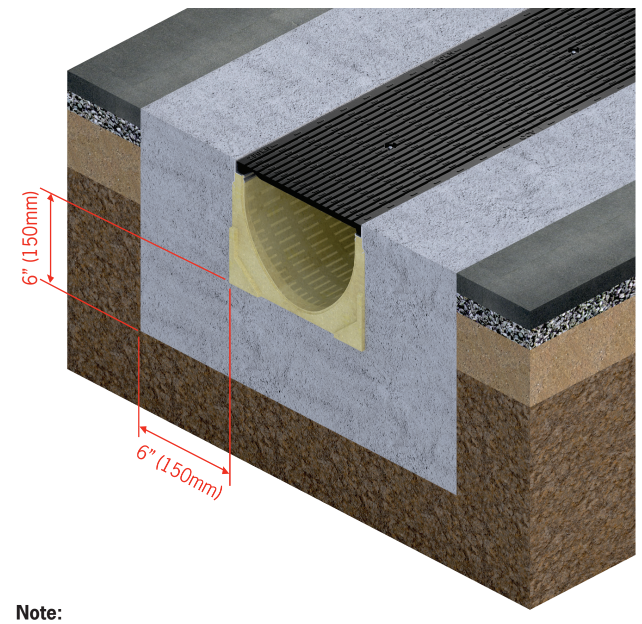
Installation sections

12 in. (300mm) Channels
BLOCK PAVERS - EN 1433 Class B



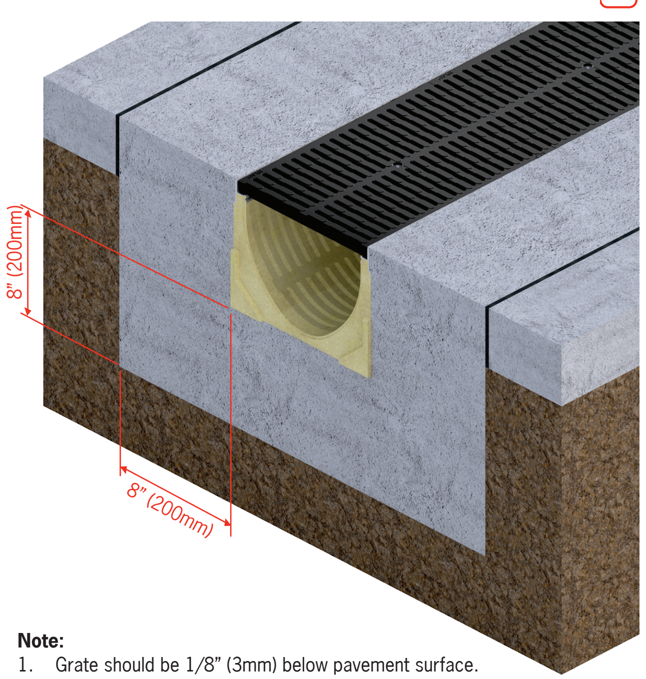
Note:
1. Grate should be 1/8" (3mm) below pavement surface.

12 in. (300mm) Channels
ASPHALT - EN 1433 Class C



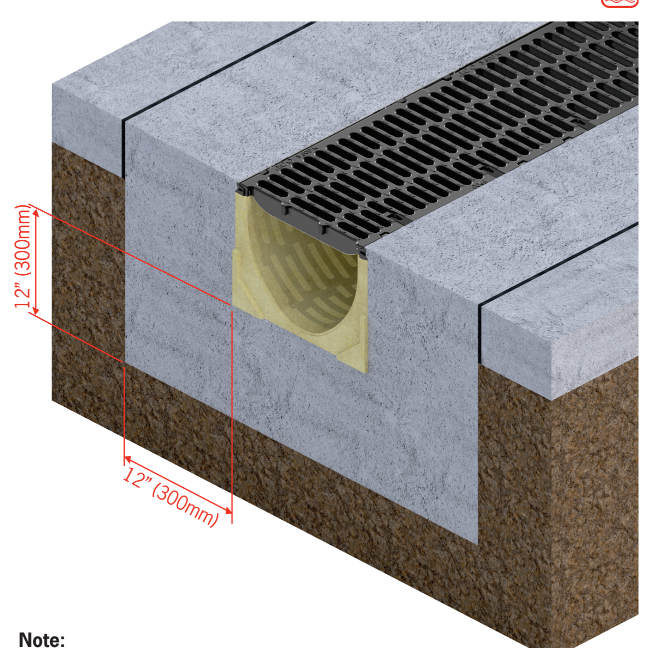
Note:
1. Grate should be 1/8" (3mm) below pavement surface.

12 in. (300mm) Channels
CONCRETE - EN 1433 Class E



Note:
1. Grate should be 1/8" (3mm) below pavement surface.

12 in. (300mm) Channels
CONCRETE - EN 1433 Class F



Note:
1. Grate should be 1/8" (3mm) below pavement surface.

Glossary

AASHTO - American Association of State Highway & Transportation Officials.

ADA - Americans with Disability Act. *See page 140.*

Anti-shunt lugs - interlocking details on grate and edge rail prevent longitudinal movement - *see Product pages.*

Anti-slip grates - slip resistance of grates has been tested using ASTM E303. *See page 141.*

AS 3996 - Australian Access Covers & Grates standard detailing Bicycle Safe grate specifications. *See page 140.*

ASME - American Society of Mechanical Engineers.

ASTM - American Society for Testing and Materials.

Bell end - flared end of pipe to accept a certain pipe size inside - similar to coupler.

Bicycle safe - grate with slots that reduce 'tram-lining' of tires. *See page 140.*

Bolt sizes - diameter - pitch per inch x length (from seat of head to base).

Catchment area - paved area that will collect liquids. *See page 142.*

Cast-in-place - trench that is produced during concrete pour by removable forms.

Catch basin - large basin to collect liquid into underground pipe work.

CFS - cubic foot per second - measure of flow.

Channel - individual modular unit.

Chemical resistance - ability to withstand specified chemicals.

Corrosion resistance - ability to withstand weathering.

Cut-outs - shaped plastic inserts cast in ends of polymer concrete catch basins to enable easy removal of material for channel connection.

DrainLok™ - ACO's patented boltless locking system for KlassikDrain and SlabDrain HK Series. *See page 15 & 98.*

Drill-outs - shaped recesses cast in polymer concrete unit to enable easy removal of material for pipe/channel connection.

Ductile iron - pig iron with magnesium added to provide added durability and strength. Often referred to as spheroidal graphite (SG) iron.

Edge protection - metal edge rail to prevent impact or general damage to trench body - *see page 136.*

EN 1433 - international load standard supersedes DIN 19580. *See page 132.*

Foul air trap - shaped pipe section to prevent odors traveling up from underground waste water system.

Free area - area for water flow. Determined by clear opening (width) and invert depth. *See page 9.*

Freestyle - new semi-custom grates. *See page 20.*

FRP - fiber reinforced plastic.

Galvanized steel - black steel with protective galvanized coating.

GIC - ACO's proprietary software program to calculate grate intake hydraulics. *See page 147.*

GPM - Gallons per Minute - measure of flow.

Grade - angle of pavement slope. *See page 142.*

Gray iron - pig iron melted in a furnace and poured into molds.

Grate hydraulics - performance of liquid entering grate openings. *See page 146.*

Ground slope - percentage of slope along length of trench. *See page 142.*

Heel resistant - ASME standard stating maximum grate slot size of 0.31" (8mm), deemed safe for heeled shoes. *See page 140.*

Heel safety - ACO stipulated criteria of maximum grate slot size of 0.25" (6.5mm), deemed safe for stiletto shoes. *See page 140.*

Hydro - ACO's proprietary software program to accurately calculate trench hydraulics. *See page 143.*

Hydrological cycle - cycle of water from oceans to rainfall and back to the ocean.

In-line catch basin - similar width basin connected to trench which acts as exit point to underground pipe work.

Invert depth - depth from top of grate to inside base of channel. *See page 9.*

kN - kilonewton - measurement of force, 1kN = 224.8lbs (102kg) of force.

LEED (Leadership in Energy and Environmental Design) - promotes whole building approach to sustainability. *See page 138.*

Lateral intake - liquid entering the trench from surrounding paved area.

Male - has protruding details to interconnect with a female piece to enable a good fit.

Low Impact Design (LID) - collection, treatment and reuse of rainwater. *See page 138.*

Manning's equation - (steady uniform flow) equation for calculating flow in pipes or culverts. Does not allow for lateral intake of liquids.

Manning's roughness coefficient - measure of roughness of a material's surface. *See page 137.*

Non-uniform flow - irregular flow velocity in trench due to continuous lateral intake. *See page 142.*

Open swale - cast-in-place dish in paved area with little depth and no grate.

Overall depth - depth from top of grate to underside of channel.

Pavement - paved area surrounding trench.

Plain end - section of pipe, will require coupler connection.

Polymer concrete - mineral aggregates mixed with a resin binding agent. *See page 136.*

Ponding Analysis - calculated temporary flooding deemed acceptable for certain projects. *See page 145.*

PowerLok™ - ACO's patented boltless locking system consisting of a sliding clip that locks onto the edge rail. *See page 64.*

psi - pounds per square inch.

QuickLok™ - ACO's patented boltless locking system consisting of shaped stud and spring clip. *See page 16.*

Scheduler - ACO's proprietary software program to illustrate/profile trench layouts. *See page 148.*

SF groove - void at channel joint to allow application of a sealant. *See page 97.*

Slip resistance - measure of coefficient of friction of grate surface. *See page 140.*

Socket - recess to accept a pipe size inside - similar to a coupler, see also 'Bell end'.

Spigot - section of pipe, will require a coupler connection, see also 'Plain end'.

Stainless steel - mild steel with a minimum of 11% chromium added to provide enhanced corrosion resistance. There are a wide number of stainless steels available, each with differing properties. ACO grates are Grade 304 austenitic stainless steel.

Steady uniform flow - constant flow velocity in trench/pipe. See Manning's Equation.

Sustainable Drainage (SUDS/WSUDS) - low impact design (LID) leads to collection, treatment and reuse of rainwater. *See page 138.*

Trench - complete drain system in paved area.

USGBC (U.S. Green Building Council) - promotes environmentally responsible, profitable and healthy construction. *See page 7.*

Visualizer - online grate selection aid. *See page 18/141.*

Other ACO products

Surface water drainage

ACO Sport
Surface drainage and building accessories for track & field.

ACO Infrastructure
Surface drainage products engineered for highways, urban roads and bridges.

Aquaduct
Custom design and manufacture of fiberglass trench drain systems.

ACO Duct
Linear ducting system with removable solid covers.

ACO Environment
Oil water separator and spill containment systems.

ACO Wildlife
Tunnel and fence system to guide amphibians and other small creatures safely across roads.

ACO StormBrixx
A unique and patented plastic geocellular storm water management system.

ACO Self
Simple drainage and building component for use around the home, garden and office.

Building drainage

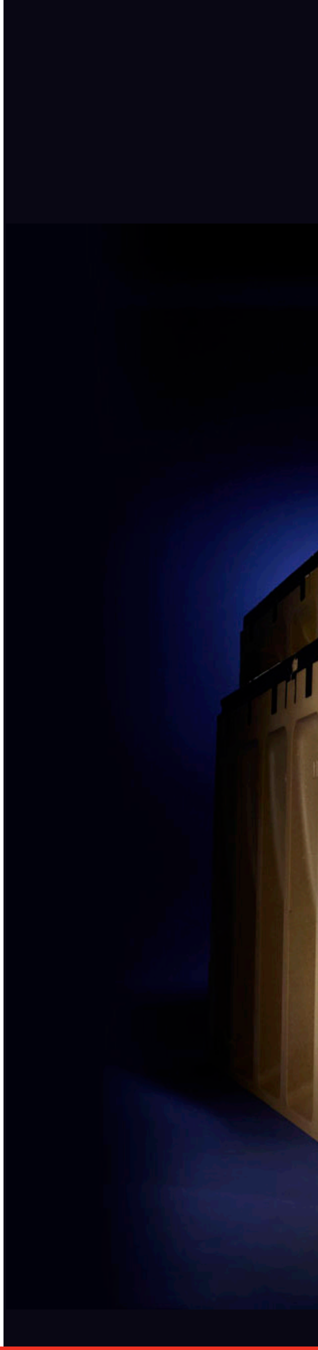
QuARTz ACO ShowerDrain
Bathroom drainage.

ACO BuildLine
Drainage products for thresholds, balconies, green roofs and building façades.

ACO Stainless
Stainless steel trench drains.

ACO Floor Drain
Stainless steel floor drains.

ACO Pipe
Stainless steel push-fit pipe system.



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