Table 5-3
Advantages and disadvantages of various types of bar screens

Type of screen	Advantages	Disadvantages
Chain-driven screen		
Front clean/ back return	Multiple cleaning elements (short cleaning cycle)	Unit has submerged moving parts that require channel dewatering for maintenance
	Used for heavy-duty applications	Less efficient screenings removal, i.e., carryover of residual screenings to screened wastewater channel
Front clean/ front return	Multiple cleaning elements (short cleaning cycle)	Unit has submerged moving parts that require channel dewatering for maintenance
	Very little screenings carryover	Submerged moving parts (chains, sprockets, and shafts) are subject to fouling
		Heavy objects may cause rake to jam
Back clean/ back return	Multiple cleaning elements (short cleaning cycle)	Unit has submerged moving parts that require channel dewatering for maintenance
	Submerged moving parts (chains, sprockets, and shafts) are protected by bar rack	Long rake teeth are susceptible to breakage
		Some susceptibility to screenings carryover
Reciprocating rake	No submerged moving parts; maintenance and repairs can be done above operating floor	Unaccounted for high channel water level can submerge rake motor and cause motor burnout
	Can handle large objects (bricks, tires, etc.)	Requires more headroom than other screens
	Effective raking of screenings and efficient discharge of screenings	Long cycle time; raking capacity may be limiting
	Relatively low operating and maintenance costs	Grit accumulation in front of bar may impede rake movement
	Stainless-steel construction reduces corrosion	Relatively high cost due to stainless-steel construction
	High flow capacity	
Catenary	Sprockets are not submerged; most maintenance can be done above the operating floor	Because design relies on weight of chain for engagement of rakes with bars, chains are very heavy and difficult to handle
	Required headroom is relatively low	Because of the angle of inclination of the screen (45 to 75°), screen has a large footprint
	Multiple cleaning elements (short cleaning cycle)	Misalignment and warpage can occur when rakes are jammed
	Can handle large objects	May emit odors because of open design
	Very little screenings carryover	
Continuous belt	Most maintenance can be done above operating floor	Overhaul or replacement of the screening elements is a time-consuming and expensive operation
	Unit is difficult to jam	

bar screen from the front or back. Each type has its advantages and disadvantages, although the general mode of operation is similar. In general, front cleaned, front return screens (see Fig. 5–3*a*) are more efficient in terms of retaining captured solids, but they are less rugged and are susceptible to jamming by solids that collect at the base of the rake. Front cleaned, front return screens are seldom used for plants serving combined sewers where large objects can jam the rakes. In front cleaned, back return screens, the cleaning rakes return to the bottom of the bar screen on the downstream side of the screen, pass under the bottom of the screen, and clean the bar screen as the rake rises. The potential for jamming is minimized, but a hinged plate, which is also subject to jamming, is required to seal the pocket under the screen.

In back cleaned screens, the bars protect the rake from damage by the debris. However, a back cleaned screen is more susceptible to solids carryover to the downstream side, particularly as rake wipers wear out. The bar rack of the back cleaned, back return screens is less rugged than the other types because the top of the rack is unsupported so the rake tines can pass through. Most of the chain-operated screens share the disadvantage of submerged sprockets that require frequent operator attention and are difficult to maintain. Additional disadvantages include the adjustment and repair of the heavy chains, and the need to dewater the channels for inspection and repair of submerged parts.

Reciprocating Rake (Climber) Screen The reciprocating-rake-type bar screen (see Fig. 5–3*b*) imitates the movements of a person raking the screen. The rake moves to the base of the screen, engages the bars, and pulls the screenings to the top of the screen where they are removed. Most screen designs utilize a cogwheel drive mechanism for the rake. The drive motors are either submersible electric or hydraulic type. A major advantage is that all parts requiring maintenance are above the waterline and can be easily inspected and maintained without dewatering the channel. The front cleaned, front return feature minimizes solids carryover. The screen uses only one rake instead of multiple rakes that are used with other types of screens. As a result, the reciprocating rake screen may have limited capacity in handling heavy screenings loads, particularly in deep channels where a long "reach" is necessary. The high overhead clearance required to accommodate the rake mechanism can limit its use in retrofit applications.

Catenary Screen A catenary screen is a type of front cleaned, front return chain-driven screen, but it has no submerged sprockets. In the catenary screen (see Fig. 5–3*c*), the rake is held against the rack by the weight of the chain. If heavy objects become jammed in the bars, the rakes pass over them instead of jamming. The screen, however, has a relatively large "footprint" and thus requires greater space for installation.

Continuous Belt Screen The continuous belt screen is a relatively new development for use in screening applications in the United States. It is a continuous, self-cleaning screening belt that removes fine and coarse solids (see Fig. 5–3*d*). A large number of screening elements (rakes) are attached to the drive chains; the number of screening elements depends on the depth of the screen channel. Because the screen openings can range from 0.5 to 30 mm (0.02 to 1.18 in), it can be used as either a coarse or a fine screen. Hooks protruding from the belt elements are provided to capture large solids such as cans, sticks, and rags. The screen has no submerged sprocket.

Design of Coarse Screen Installations. Considerations in the design of screening installations include (1) location; (2) approach velocity; (3) clear openings between bars or mesh size; (4) headloss through the screens; (5) screenings handling, processing, and disposal; and (6) controls.

Because the purpose of coarse screens is to remove large objects that may damage or clog downstream equipment, in nearly all cases, they should be installed ahead of the grit chambers. If grit chambers are placed before screens, rags and other stringy material could foul the grit chamber collector mechanisms, wrap around air piping, and settle with the grit. If grit is pumped, further fouling or clogging of the pumps will likely occur.

In hand-cleaned installations, it is essential that the velocity of approach be limited to approximately 0.45 m/s (1.5 ft/s) at average flow to provide adequate screen area for accumulation of screenings between raking operations. Additional area to limit the velocity may be obtained by widening the channel at the screen and by placing the screen at a flatter angle to increase the submerged area. As screenings accumulate, partially plugging the screen, the upstream head will increase, submerging new areas for the flow to pass through. The structural design of the screen should be adequate to prevent collapse if it becomes plugged completely.

For most mechanically cleaned coarse screen installations, two or more units should be installed so that one unit may be taken out of service for maintenance. Slide gates or recesses in the channel walls for the insertion of stop logs should be provided ahead of, and behind, each screen so that the unit can be dewatered for screen maintenance and repair. If only one unit is installed, it is absolutely essential that a bypass channel with a manually cleaned bar screen be provided for emergency use. Sometimes the manually cleaned bar screen is arranged as an overflow device if the mechanical screen should become inoperative, especially during unattended hours. Flow through the bypass channel normally would be prevented by a closed slide or sluice gate. The screen channel should be designed to prevent the settling and accumulation of grit and other heavy materials. An approach velocity of at least 0.4 m/s (1.25 ft/s) is recommended to minimize solids deposition in the channel. To prevent the pass-through of debris at peak flowrates, the velocity through the bar screen should not exceed 0.9 m/s (3 ft/s).

The velocity through the bar screen can be controlled by installation of a downstream head control device such as a Parshall flume, or, for screens located upstream of a pumping station, by controlling the wetwell operating levels. If the channel velocities are controlled by wetwell levels, lower velocities can be tolerated provided flushing velocities occur during normal operating conditions.

Headloss through mechanically cleaned coarse screens is typically limited to about 150 mm (6 in) by operational controls. The raking mechanisms are operated normally based on differential headloss through the screen or by a time clock. For time clock operation, a cycle length of approximately 15 min is recommended; however, either a high-water or high-differential contact should be provided that will place the screen in continuous operation when needed.

Hydraulic losses through bar screens are a function of approach velocity and the velocity through the bars. The headloss through coarse screens can be estimated using the following equation:

$$h_L = \frac{1}{C}\left(\frac{V^2 - v^2}{2g}\right) \tag{5-1}$$