from manufacturers and suppliers approved by the Commission are permitted to be used for sewerage application.

2.1.4 Requirements and Limitations for Use of Certain Pipe Material

Unless the exemption is granted by the Commission, the following limitations or requirements shall be followed when selecting the pipe material:

I) Gravity Sewer

a) VC
   i) Only size 150 mm or above shall be used.
   ii) The minimum size for public sewer shall be at least 225 mm.
   iii) Pipe shall not be used in unstable ground.
   iv) Flexible joints are recommended.

b) RC
   i) Pipe protection linings are required.
   ii) Only sizes 300mm and above are allowed to be used.
   iii) Flexible joints are recommended.

c) GRP
   i) Pipe shall not be used in ground contaminate with high concentration of chemicals such as solvent that can degrade the pipe.
   ii) Pipe shall not accept any industrial or other aggressive discharges that may affect the pipe integrity.
   iii) Pipe shall be used only when no fittings are required.
   iv) Only size 600 mm or above are allowed.

d) DI
   i) The use is only allowed for applications needed high pipe strength.
   i) Pipe protection linings and coatings are required.
   ii) Polyethylene sleeving is required for all buried applications.

e) HDPE
   i) Pipe shall not be used in ground contaminated with high concentration of chemicals such as solvent that can degrade the pipe.

diameters of VC pipe are imported. VC pipes are classified according to the pipe ring crushing strength which depend on the manufacturing process and quality. VC pipes and fittings can be produced either unglazed or glazed on the interior and/or exterior. When glazed they need not be glazed on the jointing surfaces of the spigot and socket. VC pipes which are available in Malaysia are normally manufactured with spigot-socket flexible joints. Most manufacturers offer rubber ring seals. However, polyurethane seals are sometimes offered by some manufacturers.

Vitrified clay pipe has extra chemical resistance that is suitable for sewerage applications. The VC pipe may be used even under very corrosive sewage environment. However, the potential for infiltration is great and must be minimized by careful laying procedures on site.

Vitrified clay pipe are permitted for gravity sewers. The minimum permissible size for public gravity sewer shall not be less than 225 mm and for service connection shall not be less than 150 mm.

VC pipes and fittings shall conform to the requirements of MS1061. Pipe strength is classified by the crushing strength (FN) value tested in accordance with BS EN 295-3. The crushing strength for pipe with DN150 shall not be less than 22 kN/m. The crushing strength of the pipe with size ≥ DN 225 is classified by class number. All VC pipes and fittings shall be furnished with spigot-socket flexible joints and rubber ring seals or polyurethane seals. Glazing of VC pipe and fittings are preferred.

2.1.6 Reinforced Concrete Pipe

Reinforced concrete (RC) pipe is manufactured in Malaysia in diameters from 150 mm to 3600 mm. The standard pipe length is 3.05 m. RC pipe is classified according to pipe crushing test load or the three-edge bearing strength which varies with wall thickness and reinforcement.

Common reinforced concrete pipes are not resistant to acidic corrosion which occurs in certain septic sewage conditions. The cement used to manufacture concrete pipe shall be factory produced by the cement manufacturer. Pipes can be manufactured using Portland Cement, Portland Blast Furnace Cement, Portland Pulverised Fuel Ash Cement and Sulphate Resisting Portland Cement and Rapid Hardening Portland Cement. To improve the corrosion resistance, high alumina cement mortar lining and sacrificial lining have been used. Low heat and super-sulphated cements have also been found in some

tests to improve the corrosion resistance. The inclusion of calcareous or limestone aggregate is another measure found to improve corrosion resistance. To resist corrosion by neutral sulphates occurring in aggressive soils and groundwater, RC pipes are sometimes manufactured using sulphate resistance cement and where not available, Portland Pulverised Fuel Ash Cement or Portland Blast Furnace Cement shall be used with the approval from relevant authority.

RC pipes are permitted for gravity sewers of diameter DN300 and larger. Pipe shall be of Standard Strength or higher as determined from structural design. RC pipes linings shall consist of either 12mm thick high alumina cement or 38 mm thick (as appropriate) sacrificial concrete lining. Other linings may be used if approval from the Commission is obtained. Concrete pipe junctions shall be fixed to the main pipe by the pipe manufacturer and fabricated to clay pipe dimensions. Flexible joints which utilise a rubber ring to join a rebated joint and spigot to a socket are commonly used and are recommended. Ogee joint (fixed joint) shall be used in conjunction with concrete bedding haunching only. RC pipe when used for pipe jacking purpose, shall comply with BS 5911. The RC pipes also incorporate rebated joints with join elastomeric ring seals either integrated in the unit or supplied separately.

2.1.7 Ductile Iron Pipe

Ductile Iron (ID) pipe manufactured in Malaysia for diameters from 80 mm to 1200 mm. The diameter imported pipe can be up to 2000 mm. Standard lengths are 6.0 m. DI pipe is classified according to wall thickness. The pressure rating of the pipe increases with an increase in wall thickness. Commonly used pipe strength is class K9 and shall comply with BS EN 598 for working pressure exceeding 6 bars.

DI pipe is permitted for force mains and internal pipings of pump stations. DI pipe shall be used for gravity sewers only where it is needed to take the advantage of the high strength of ductile iron, e.g. shallow cover sewers subjected to high live load or sewers of above ground applications.

Pipes shall have flexible joints, i.e. spigot-socket rubber seal joints or mechanical joints, except for pump station pipeworks and valve connections where flange joints shall be used.

Ductile iron will corrode when exposed to certain aggressive groundwaters and conveying certain aggressive water. Therefore, internal lining and external coating protection are required to protect against corrosions. Unless otherwise approved by the Commission, all ductile iron pipes shall