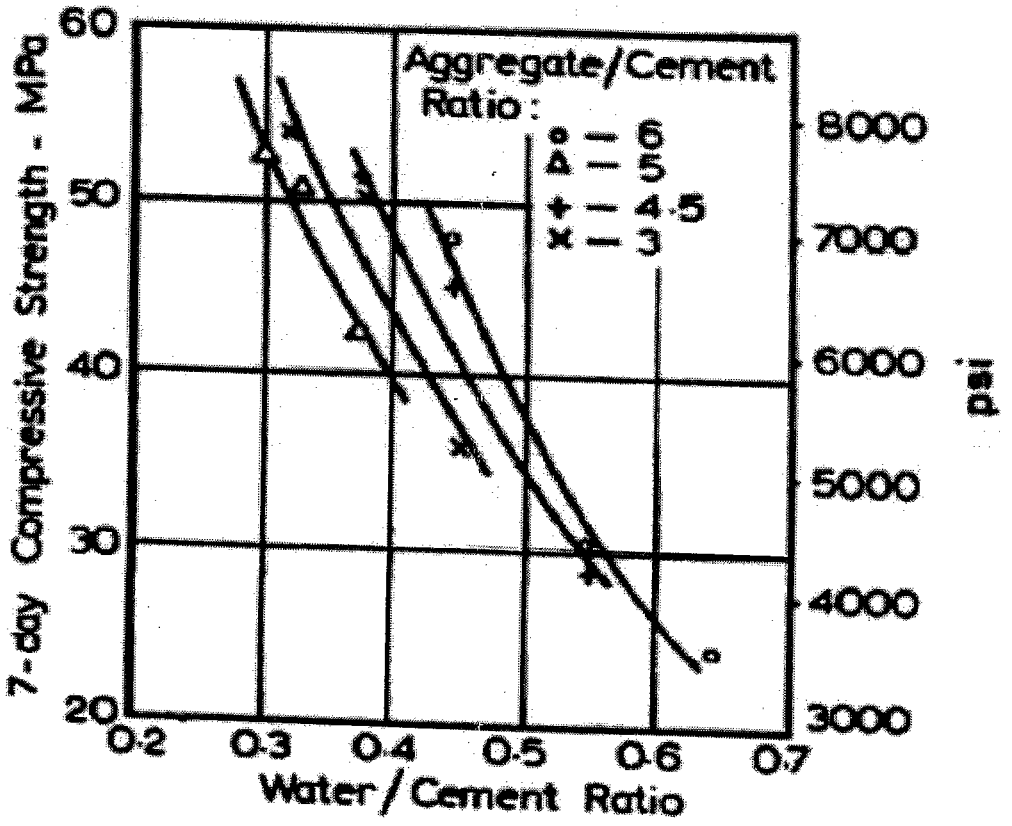
Hardened Concrete

Factors affecting strength of concrete

- Water/cement ratio and degree of compaction
- Ratio of cement to aggregate
- Grading, surface texture, shape, strength and stiffness of aggregate particles
- Maximum size of aggregate.

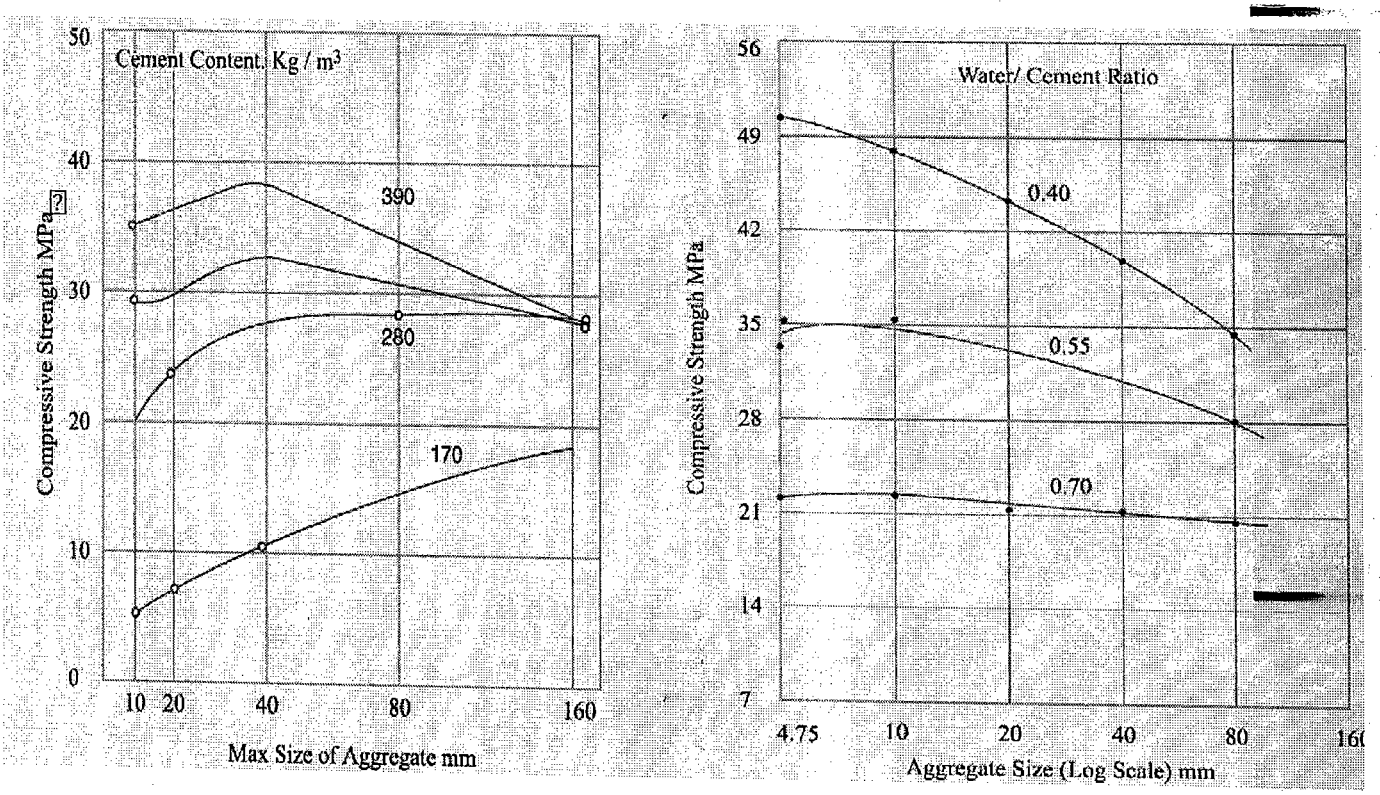
Influence of aggregate/cement ratio

- The aggregate/cement ratio, is only a secondary factor in the strength of concrete but it has been found that, for a constant water/cement ratio, a leaner mix leads to a higher strength.
- Some water may be absorbed by the aggregate: a larger amount of aggregate absorbs a greater quantity of water, the effective water/cement ratio being thus reduced.
- A higher aggregate content would lead to lower shrinkage and lower bleeding, and therefore to less damage to the bond between thee aggregate and the cement paste
- As a result, in a leaner mix, the voids form a smaller fraction off the total volume of concrete, and it is these voids that have an adverse effect on strength



Effect of Maximum size of Aggregate

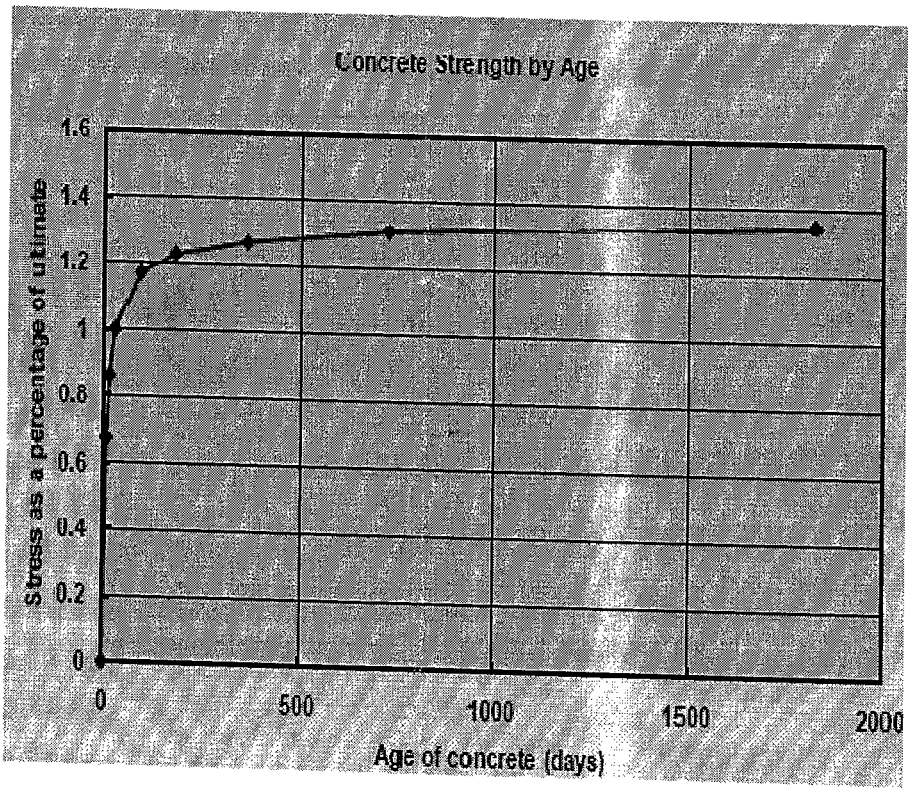
- The larger the aggregate the lower is the total surface area and, therefore, the lower is the requirement of water for the given workability.
- The use of larger size aggregate did not contribute to higher strength as expected from the theoretical considerations due to the following reasons.
- The larger maximum size aggregate gives lower surface area for developments of gel bonds which is responsible for the lower strength of the concrete.
- Secondly bigger aggregate size causes a more heterogeneity in the concrete which will prevent the uniform distribution of load when stressed.
- When large size aggregate is used, due to internal bleeding, the transition zone will become much weaker due to the development of micro cracks which result in lower compressive strength.



Age of concrete

With an increase in age, the degree of hydration generally increases increasing the gel/space ratio so that strength increases
Increase in the strength of concrete (at same w/c ratio) with increase in early age (from 1 to 28 days) of concrete

Age of Concrete	7 days	14 days	28 days	3 months	6 months	1 year	2 year	5 year
Strength Ratio	0.67	0.86	1.00	1.17	1.23	1.27	1.31	1.35



Influence of properties of coarse aggregate

- The relation between the flexural and compressive strengths depends on the type of coarse aggregate because the properties of aggregate, especially its shape and surface texture, affect the ultimate strength in compression very much less than the strength in tension or the cracking load in compression.
- In experimental concrete, entirely smooth coarse aggregate led to a lower compressive strength, typically by 10 per cent, than when roughened.
- The influence of the type of coarse aggregate on the strength of concrete varies in magnitude and depends on the water/cement ratio of the mix.
- For water/cement ratios below 0.4, the use of crushed aggregate has resulted in strengths up to 38 per cent higher than when gravel is used.
- With an increase in the water/cement ratio to 0.5, the influence of aggregate falls off, presumably because the strength of the hydrated cement paste itself becomes paramount and, at a water/cement ratio of 0.65, no difference in the strengths of concretes made with crushed rock and gravel has observed

Influence of temperature on strength

- The rise in the curing temperature speeds up the chemical reactions of hydration and thus affects beneficially the early strength of concrete without any ill-effects on the later strength.
- Rapid initial hydration appears to form products of a poorer physical structure, probably more porous, so that a proportion of the pores will always remain unfilled.
- The gel//space ratio rule that this will lead to a lower strength compared with a less porous, though slowly hydrating, cement paste in which a high gel//space ratio will eventually be reached.