

[illegible][illegible]

1. The first part of the document is a list of references. The references are listed in a standard format, with the author's name, the title of the work, and the publisher. The references are as follows:

1. J. H. Van Veen, *The History of the Netherlands*, 1910, 1911, 1912, 1913, 1914, 1915, 1916, 1917, 1918, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929, 1930, 1931, 1932, 1933, 1934, 1935, 1936, 1937, 1938, 1939, 1940, 1941, 1942, 1943, 1944, 1945, 1946, 1947, 1948, 1949, 1950, 1951, 1952, 1953, 1954, 1955, 1956, 1957, 1958, 1959, 1960, 1961, 1962, 1963, 1964, 1965, 1966, 1967, 1968, 1969, 1970, 1971, 1972, 1973, 1974, 1975, 1976, 1977, 1978, 1979, 1980, 1981, 1982, 1983, 1984, 1985, 1986, 1987, 1988, 1989, 1990, 1991, 1992, 1993, 1994, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002, 2003, 2004, 2005, 2006, 2007, 2008, 2009, 2010, 2011, 2012, 2013, 2014, 2015, 2016, 2017, 2018, 2019, 2020, 2021, 2022, 2023, 2024, 2025, 2026, 2027, 2028, 2029, 2030, 2031, 2032, 2033, 2034, 2035, 2036, 2037, 2038, 2039, 2040, 2041, 2042, 2043, 2044, 2045, 2046, 2047, 2048, 2049, 2050, 2051, 2052, 2053, 2054, 2055, 2056, 2057, 2058, 2059, 2060, 2061, 2062, 2063, 2064, 2065, 2066, 2067, 2068, 2069, 2070, 2071, 2072, 2073, 2074, 2075, 2076, 2077, 2078, 2079, 2080, 2081, 2082, 2083, 2084, 2085, 2086, 2087, 2088, 2089, 2090, 2091, 2092, 2093, 2094, 2095, 2096, 2097, 2098, 2099, 2100, 2101, 2102, 2103, 2104, 2105, 2106, 2107, 2108, 2109, 2110, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2120, 2121, 2122, 2123, 2124, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2132, 2133, 2134, 2135, 2136, 2137, 2138, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2150, 2151, 2152, 2153, 2154, 2155, 2156, 2157, 2158, 2159, 2160, 2161, 2162, 2163, 2164, 2165, 2166, 2167, 2168, 2169, 2170, 2171, 2172, 2173, 2174, 2175, 2176, 2177, 2178, 2179, 2180, 2181, 2182, 2183, 2184, 2185, 2186, 2187, 2188, 2189, 2190, 2191, 2192, 2193, 2194, 2195, 2196, 2197, 2198, 2199, 2200, 2201, 2202, 2203, 2204, 2205, 2206, 2207, 2208, 2209, 2210, 2211, 2212, 2213, 2214, 2215, 2216, 2217, 2218, 2219, 2220, 2221, 2222, 2223, 2224, 2225, 2226, 2227, 2228, 2229, 2230, 2231, 2232, 2233, 2234, 2235, 2236, 2237, 2238, 2239, 2240, 2241, 2242, 2243, 2244, 2245, 2246, 2247, 2248, 2249, 2250, 2251, 2252, 2253, 2254, 2255, 2256, 2257, 2258, 2259, 2260, 2261, 2262, 2263, 2264, 2265, 2266, 2267, 2268, 2269, 2270, 2271, 2272, 2273, 2274, 2275, 2276, 2277, 2278, 2279, 2280, 2281, 2282, 2283, 2284, 2285, 2286, 2287, 2288, 2289, 2290, 2291, 2292, 2293, 2294, 2295, 2296, 2297, 2298, 2299, 2300, 2301, 2302, 2303, 2304, 2305, 2306, 2307, 2308, 2309, 2310, 2311, 2312, 2313, 2314, 2315, 2316, 2317, 2318, 2319, 2320, 2321, 2322, 2323, 2324, 2325, 2326, 2327, 2328, 2329, 2330, 2331, 2332, 2333, 2334, 2335, 2336, 2337, 2338, 2339, 2340, 2341, 2342, 2343, 2344, 2345, 2346, 2347, 2348, 2349, 2350, 2351, 2352, 2353, 2354, 2355, 2356, 2357, 2358, 2359, 2360, 2361, 2362, 2363, 2364, 2365, 2366, 2367, 2368, 2369, 2370, 2371, 2372, 2373, 2374, 2375, 2376, 2377, 2378, 2379, 2380, 2381, 2382, 2383, 2384, 2385, 2386, 2387, 2388, 2389, 2390, 2391, 2392, 2393, 2394, 2395, 2396, 2397, 2398, 2399, 2400, 2401, 2402, 2403, 2404, 2405, 2406, 2407, 2408, 2409, 2410, 2411, 2412, 2413, 2414, 2415, 2416, 2417, 2418, 2419, 2420, 2421, 2422, 2423, 2424, 2425, 2426, 2427, 2428, 2429, 2430, 2431, 2432, 2433, 2434, 2435, 2436, 2437, 2438, 2439, 2440, 2441, 2442, 2443, 2444, 2445, 2446, 2447, 2448, 2449, 2450, 2451, 2452, 2453, 2454, 2455, 2456, 2457, 2458, 2459, 2460, 2461, 2462, 2463, 2464, 2465, 2466, 2467, 2468, 2469, 2470, 2471, 2472, 2473, 2474, 2475, 2476, 2477, 2478, 2479, 2480, 2481, 2482, 2483, 2484, 2485, 2486, 2487, 2488, 2489, 2490, 2491, 2492, 2493, 2494, 2495, 2496, 2497, 2498, 2499, 2500, 2501, 2502, 2503, 2504, 2505, 2506, 2507, 2508, 2509, 2510, 2511, 2512, 2513, 2514, 2515, 2516, 2517, 2518, 2519, 2520, 2521, 2522, 2523, 2524, 2525, 2526, 2527, 2528, 2529, 2530, 2531, 2532, 2533, 2534, 2535, 2536, 2537, 2538, 2539, 2540, 2541, 2542, 2543, 2544, 2545, 2546, 2547, 2548, 2549, 2550, 2551, 2552, 2553, 2554, 2555, 2556, 2557, 2558, 2559, 2560, 2561, 2562, 2563, 2564, 2565, 2566, 2567, 2568, 2569, 2570, 2571, 2572, 2573, 2574, 2575, 2576, 2577, 2578, 2579, 2580

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COAL OPTION

Question 1: Pillar Design (20 Marks)

- (a) Derive an expression to show what percentage of a pillar's safety factor is lost if its width decreases by 15% while the pillar centre distance, mining height and depth remain the same. Use the Salamon and Munro (1967) pillar strength formula. [10]
- (b) What is the relationship between time and the rate of pillar scaling? Sketch this relationship in the form of a graph to illustrate your answer. [5]
- (c) Using a neat sketch, indicate the differences between the pillar strength formulae of Salamon and Munro (1967) and van der Merwe (2003) for the range of pillar width-to-height ratios of 1 to 5. [5]

Question 2: Roof Support (30 Marks)

The immediate roof in a coal mine with 7.2 m wide bords consists of laminated mudstone and sandstone for a thickness of 0.6 m, see Figure 2.1. The individual laminae are 1.5 cm thick and they are not well bonded. Overlying this is a sandstone layer of 0.5 m thick. No coal can be left in the roof. A safety factor of 1.5 is required. Use the mechanical properties of the rock types as shown in Table 2.1.

- (a) Can the laminated layers be suspended from the sandstone beam? Motivate your answer. [5]
- (b) What is the maximum allowable spacing for roofbolts? [5]
- (c) Using the maximum spacing, what length of bolts will be required if resin anchors are used? Assume the shear strength of the resin/rock contact plane to be 1 500 kPa and that M20 rebar is to be used in 25 mm diameter holes. [5]
- (d) What length of resin capsules will be required for point anchor application? [5]
- *(e) What is the minimum yield strength of steel to be used in your design? [5]
- (f) Outline the general steps to be followed in the design of a support system based on the beam creation principle. [2]
- [8]

Table 2.1: Mechanical Properties of Selected Rock Types

Rock type	UCS (MPa)	UTS (MPa)	Shear Strength (MPa)	E (GPa)	Density (kg/m ³)
Sandstone	75	5	15	13	2 480
Shale	75	5	7	15	2 480
Siltstone	70	6	8	1	2 480
Mudstone	40	5	8	7	2 480
Dolerite	190	24	20	100	3 000
Coal	25	5	8	5	1 500

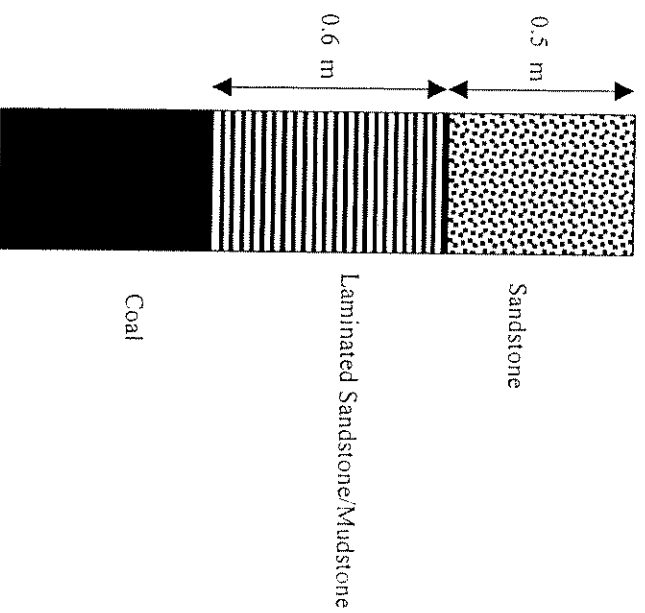


Figure 2.1

Question 3: Monitoring (20 Marks)

- (a) With the aid of a neat, annotated sketch, describe the use and basic construction of a petroscope. [8]
- (b) Sketch characteristic Time-Displacement curves resulting from extensometer measurements that conceptually indicate stable behaviour, imminent failure and possible failure at a later time. [12]

Question 4: Subsidence (10 Marks)

Using neat annotated sketches, describe the process resulting in sinkholes over bord and pillar workings at a depth less than 40 m below surface, also indicating the conditions under which sinkholes will not progress to the surface. [10]

COAL OPTION

Question 5: General (20 Marks)

All questions must be answered by marking either the True or False column on the attached sheet. Note that a box has to be ticked for each question, not just the correct answer. Please make sure that your exam number is written clearly on the answer sheet, detach it and hand it in with your examination script

Note that marks will be deducted for incorrect answers and unanswered questions.

- (a) The Slake Durability Test
- (i) is used to assess a rock sample's swelling strain when immersed in water
 - (ii) is used to evaluate floor deterioration under high load conditions
 - (iii) is used for input in the Q-system
 - (iv) should not be used to assess floor conditions in drill and blast operations
- (b) The Q-rating
- (i) can only be used for large excavations, not mine tunnels
 - (ii) can be used to determine whether a longwall overburden is likely to goaf
 - (iii) is used to assess expected floor conditions for continuous miner operations
 - (iv) does not allow for major single discontinuities in excavations
- (c) Fixed head full column resin roof bolts with dual speed resin can be classified as
- (i) stiff, passive support
 - (ii) soft, active support
 - (iii) stiff, active support
 - (iv) soft, passive support
- (d) The Point of Inflection on a subsidence profile is that point where
- (i) half of the maximum subsidence occurs
 - (ii) maximum tilt occurs
 - (iii) maximum tensile strain occurs
 - (iv) surface cracks appear
- (e) The stiffness of the loading system on pillars will be increased by
- (i) pillar wrapping
 - (ii) smart bolting in the roof
 - (iii) decreasing the road width
 - (iv) decreasing the panel width
- (f) There is a correlation between the rate of scaling of coal pillars and -
- (i) the safety factor
 - (ii) the pillar load
 - (iii) the mining depth
 - (iv) the pillar height

COAL OPTION

- (g) The "Continuous Miner Correction" for coal pillars
- (i) has the effect of decreasing pillar load because the pillar width is increased
 - (ii) is a fixed ratio of pillar strength
 - (iii) is a fixed dimension irrespective of pillar width
 - (iv) is only used in the pillar strength calculation while not affecting the pillar load
- (h) Roof deflection prior to bolt installation
- (i) is prevented by restricting the cut-out distance to less than the road width
 - (ii) is reversed by pretensioning bolts to more than 80 kN in a thinly laminated roof
 - (iii) does not occur in sandstone roofs
 - (iii) negates beam building
- (i) For rectangular pillars, the "effective width" concept
- (i) implies that the effective width can never exceed twice the minimum width
 - (ii) can not be used with the "Continuous Miner Correction"
 - (iii) means that the effective width is used in both the load and the strength calculations
 - (iv) should not be used if pillars are densely jointed
- (j) Breaker lines
- (i) are required in stooping operations in terms of the regulations of the Mine Health and Safety Act
 - (ii) must, according to the regulations, consist of timber poles
 - (iii) must be at least a double line of supports
 - (iv) are effective in holding up a goaf

20 marks

TOTAL MARKS: [100]

ROCK MECHANICS PAPER 2

27 OCTOBER 2004

COAL OPTION

EXAM NUMBER: _____

Question	TRUE	FALSE
a) The Slake Durability Test.....		
i)		
ii)		
iii)		
iv)		
b) The Q-rating.....		
i)		
ii)		
iii)		
iv)		
c) Fixed head full column....		
i)		
ii)		
iii)		
iv)		
d) The Point of Inflexion...		
i)		
ii)		
iii)		
iv)		
e) The stiffness of the loading...		
i)		
ii)		
iii)		
iv)		
f) There is a correlation.....		
i)		
ii)		
iii)		
iv)		
g) The "Continuous Miner Correction"		
i)		
ii)		
iii)		
iv)		
h) Roof deflection prior to bolt.....		
i)		
ii)		
iii)		
iv)		
i) For rectangular pillars.....		
i)		
ii)		
iii)		
iv)		
j) Breaker lines.....		
i)		
ii)		
iii)		
iv)		