University of Anbar
College of Science
Department of Physics

فيزياء المواد

Physics of Materials

المرحلة الثالثة

الكورس الاول

اعداد
م.د. قيس عبدالله عباس

7. Fracture الكسر

Simple fracture الكسر البسيط is the separation هو فصل of a body الجسم into الى two or more pieces قطع in response كاستجابة to an imposed stress جهد مسلط that is static (i.e., constant or slowly changing with time) and at temperatures that are low relative to the melting temperature درجة حرارة الذوبان of the material. Fracture can also occur يحدث from **fatigue انهيار او اجهاد** (when cyclic stresses اجهاد دوراني are imposed يسلط) and **creep** الزحف (time dependent deformation تشويه معتمد على الزمن)

7.1 Ductile Fracture الكسر المرن

Ductile fracture surfaces will have their own distinctive features on both macroscopic and microscopic levels.

لأسطح الكسر المرن سماتها المميزة على المستويين العياني والمجهري

Figure 7.1 shows schematic representations عرض تخطيطي for two characteristic macroscopic fracture profiles ملامح الكسر العيانية المميزة . The configuration التوزيع shown مبين in Figure 7.1a, is found for extremely soft metals المعادن اللينة, such as pure gold ذهب نقي and lead رصاص at room temperature.

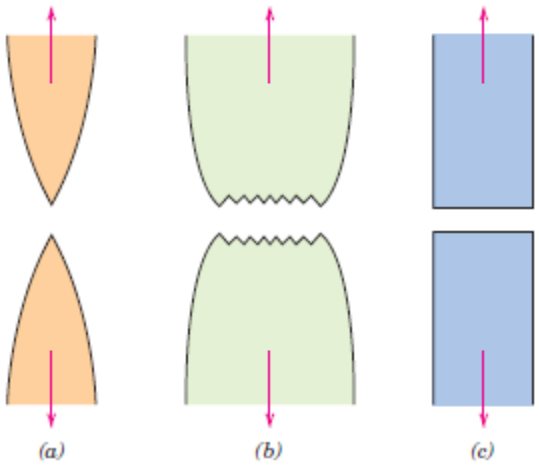

Figure 7.1 (a) Highly ductile fracture in which the specimen necks down to a point. (b) Moderately باعتدال ductile fracture after some necking. (c) Brittle fracture كسر هش without any plastic deformation تشوه لدن.

7.2 Brittle fracture الكسر الهش

Brittle fracture takes place يحدث without بدون any appreciable deformation تشوه ملحوظ and by rapid سريع crack تشقق propagation انتشار. The direction اتجاه of crack

motion حركة is very nearly perpendicular عمودية to the direction اتجاه of the applied tensile الشد stress and a relatively flat fracture surface, as indicated in Figure 7.1c.

7.3 Hardness of materials صلابة المواد

The hardness testثب اختبار measures تقيس the resistance مقاومة to penetration اختراق of the surface سطح of a material by a hard object جسم صلد. Hardness can represent تمثل resistance مقاومة to scratching الخدش or indentation اخدود صغير and a qualitative measure قياس نوعي of the strength قوة of the material. In general, in macro-hardness measurements, the load applied is ~2 N. A variety of hardness tests have been devised تم ابتكارها, but the most commonly الاكثر شيوعا used are the **Rockwell test اختبار روكويل** and the **Brinell test اختبار برينل**. Different indenters used in these tests are shown in Figure 7.2.

Indenter a small hard object used for producing an indentation in a solid in an indentation test. جسم صلب صغير يستخدم لإنتاج اخدود صغير في مادة صلبة في اختبار الاخدود .

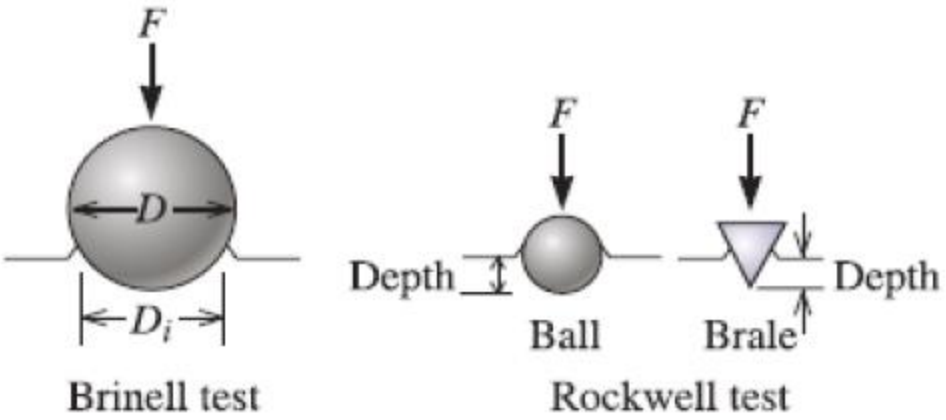

Figure 7.2 Indenters for the Brinell and Rockwell hardness tests.

7.4 Impact test اختبار الصدمة

Impact energy absorbed تمتص by the specimen العينة during failure فشل. For the **Charpy** test, the energy is usually expressed in foot-pounds (ft lb) or joules (J), where 1 ft lb = 1.356 J. The results of the **Izod** test are expressed in units of ft lb/ in. or J/ m. The ability قابلية of a material to withstand الصمود an impact blow is often referred to as the impact toughness صلابة او متانة of the material.

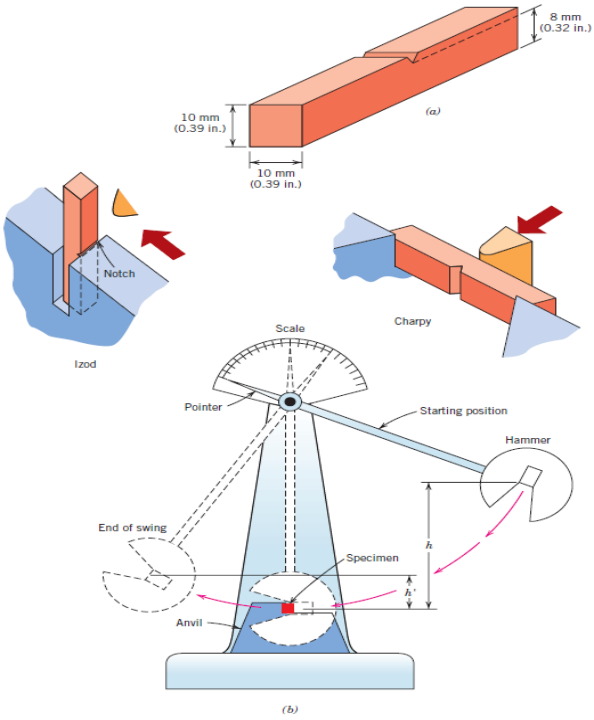

Figure 7.3 The impact test: (a) dimensions ابعاد of typical specimens عينة مثالية. (b) the Charpy and Izod tests,

7.5 Fatigue انهيار او اجهاد

Fatigue is a form هو نوع of failure الفشل that occurs يحدث الذي in structures في تراكيب subjected تحت تاثير to dynamic ديناميكي and fluctuating stresses جهد متذبذب (e.g., bridges الجسور, aircraft الطائرة, and machine components اجزاء المكائن). Under these circumstances الظروف it is possible من الممكن for failure الفشل to occur يحدث at a stress level عند مستوى اجهاد considerably الى حد كبير lower تحت than the tensile or yield strength قوة الخضوع for a static load للحمل ساكن.The term fatigue is used because this type of failure normally occurs after a lengthy period دورة طولية of repeated اعادة stress or strain cycling دورة. Fatigue is important as it is the single منفرد largest cause اكبر سبب of failure للفشل in metals في المعادن

7.6 Creep الزحف

Materials are often غالبا placed توضع in service الخدمة at elevated temperatures حرارة مرتفعة and exposed تتعرض to static mechanical stresses لاجهادات ميكانيكية ثابتة (e.g., turbine rotors محركات التورباين in jet engines محركات النفث and steam generators مولدات البخار that experience centrifugal stresses تجربة ضغوط الطرد المركزي, and high-pressure steam lines خطوط بخار عالية الضغط). Deformation تشوه under تحت such circumstances ظروف is termed يعرف creep الزحف. Defined يعرف as the time-dependent معتمد الزمن and permanent deformation تشوه دائم of materials when subjected عندما تخضع to a constant load حمل ثابت or stress, creep is normally عادة an undesirable غير مرغوب phenomenon ظاهرة and is often the limiting محدد factor عامل in the lifetime of a part. It is observed تم ملاحظته in all materials types في جميع انواع المواد; for metals it becomes important only for temperatures greater اكبر than about 0.4Tm (Tm = absolute melting temperature).

References المصادر

1- Fundamentals of Materials Science and Engineering, William D. Callister, Jr. David G. Rethwisch
2- Materials _Science_ and _Engineering_9th . William D. Callister, Jr. David G. Rethwisch